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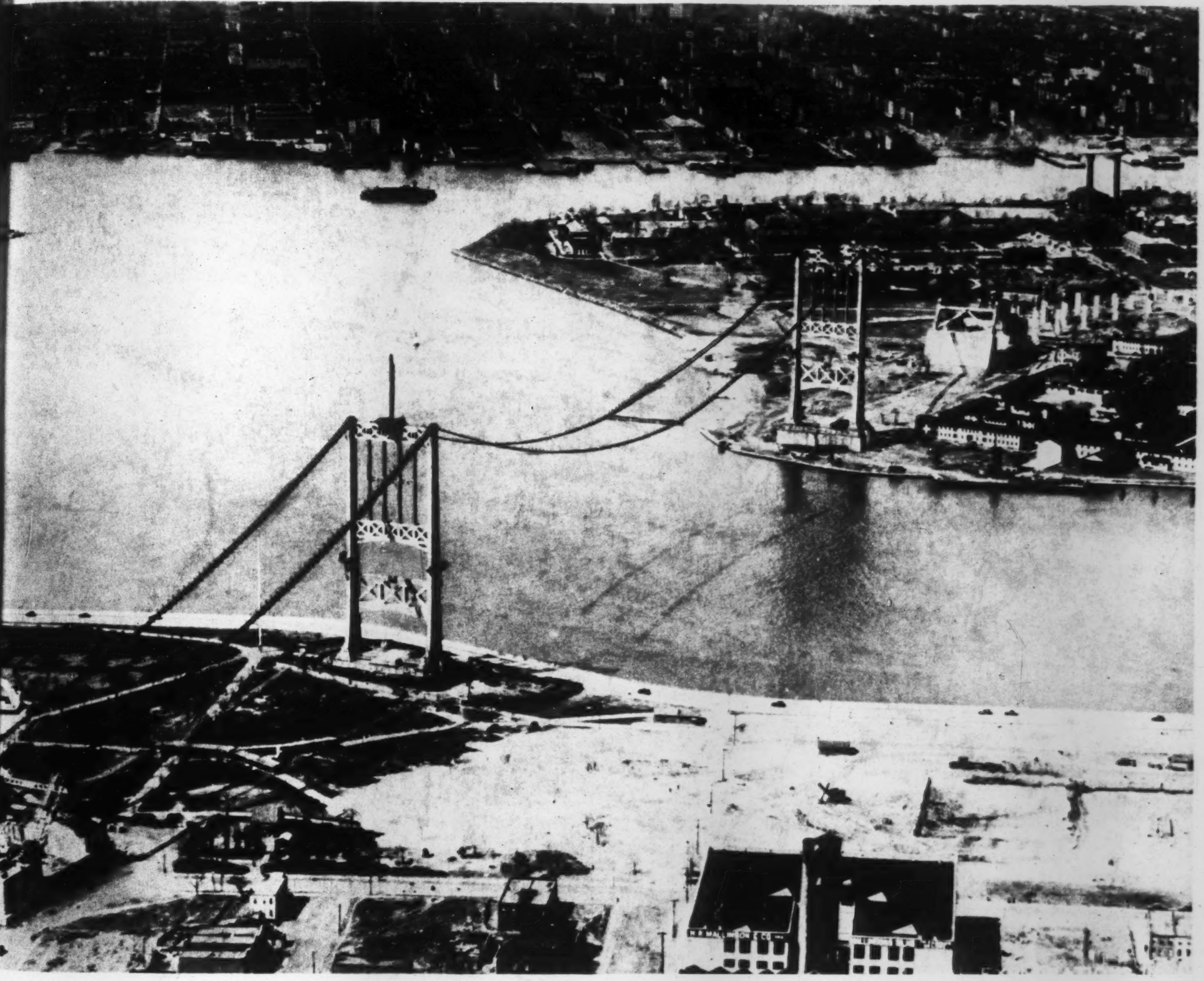
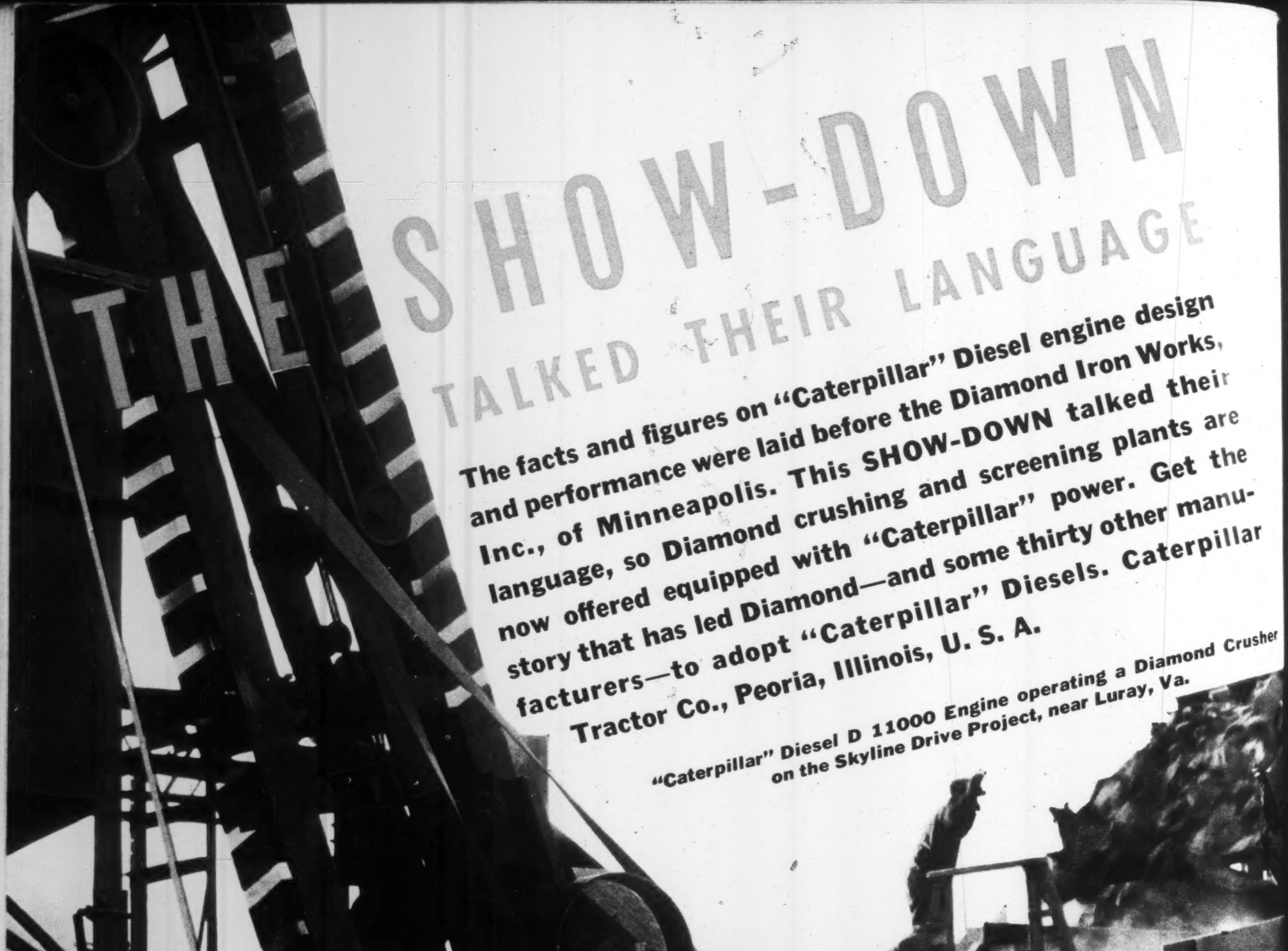


High above Hell Gate, the footwalks for the 1,380-ft. Triborough suspension span in New York are being laid for the cable spinners, whose equipment is being assembled at the anchorages for a start on cable construction about May 1

In this Issue:

An Important Article on Concreting Plant and Methods on Mississippi River Locks



THE SHOW-DOWN

TALKED THEIR LANGUAGE

The facts and figures on “Caterpillar” Diesel engine design and performance were laid before the Diamond Iron Works, Inc., of Minneapolis. This **SHOW-DOWN** talked their language, so Diamond crushing and screening plants are now offered equipped with “Caterpillar” power. Get the story that has led Diamond—and some thirty other manufacturers—to adopt “Caterpillar” Diesels. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

“Caterpillar” Diesel D 11000 Engine operating a Diamond Crusher on the Skyline Drive Project, near Luray, Va.

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A MOMENT WITH THE PUBLISHERS

Buy Through Normal Channels

NOW that the work-relief program has been enacted, the administration faces the job of making it work. Fortunately, Congress rejected most of the proposals which, during discussion of the bill, threatened to impair its usefulness. As it stands, the law promises a substantial uplift to those industries which find in construction employment for both their labor and their capital. Success now is a matter of wise administration.

And this program had better be wisely administered. We are imposing upon an already huge national debt an additional $4 billions. This must be carried and eventually amortized out of the earnings of industry and trade. So it is essential that these expenditures be so directed as to stimulate the recovery of private business. They must give private employment a substantial boost and must foster an increasing investment of private capital. Else they will but hasten the advent of runaway inflation with all its menace to our living standards and to our economic, social and political fabric.

WISE administration will comprise many factors; all of them cannot even be catalogued here. But obviously one of them is the requirement that every part of the project be so handled as to stimulate rather than cripple the established organizations of private enterprise. *To ignore this principle is to betray the intent of the project.*

One such organization is that through which equipment and materials are distributed from producers to users. It is selected for emphasis here because tentative suggestions already have transpired to the effect that government might purchase directly the materials required for construction projects. Already governmental buying practices on emergency projects have crippled the distribution organization of the industry; it would be a pathetic miscarriage for this new and unprecedented recovery effort to intensify rather than to remedy their unfortunate effects.

Direct purchasing is quite uncalled for. Only six years ago the construction industry handled a $12 billion year. The plant that distributed the materials and equipment for that work is intact. The capital invested in that trade still awaits an opportunity to earn a return. The human organization, from managers to laborers, still survives although its ranks are sadly depleted. But the organized units are there, keyed up by sharp competition to a high efficiency.

And let us never forget that the major purpose of this gigantic effort is to help fill those depleted ranks. The President sees clearly that the way to relieve unemployment is to create employment. He should see just as clearly that the soundest, quickest and most productive way to do that is to help fill the ranks of private business, not to begin the organization of a new and competitive army.

DISTRIBUTION and service costs are real costs that cover real services. They cannot be evaded by short-circuiting the normal channels of trade, for then we must improvise some temporary organization to do the job normally done by established dealers and distributors. Every practical constructor knows what havoc a defective chain of distribution can play with his over-all costs. The cumulative effect of shortages today and excessive stocks tomorrow, of wastage and spoilage resulting from faulty handling of storage, of delays and losses for want of nearby and responsible service crews: such inefficiencies may be inevitable in a war, when vast organizations *must* be improvised under pressure, but they are inexcusable in an effort designed primarily to bring existing and capable organizations more nearly up to normal strength.

If those who must buy the materials and equipment for the emergency construction program will employ the normal channels of the industry they will do more than contribute to recovery and reemployment. They will assure to the taxpayers all the economy that can be realized through a trained and competent organization, keyed up by competitive pressure to the highest efficiency.

Normal procedure in the purchase of materials and equipment as in every other particular will be essential if the President is to revive private industry, make a real dent in unemployment and assure to the taxpayers, who eventually must pay the bill, the greatest return for every dollar expended.

Willard Chevalier

ENGINEERING NEWS-RECORD

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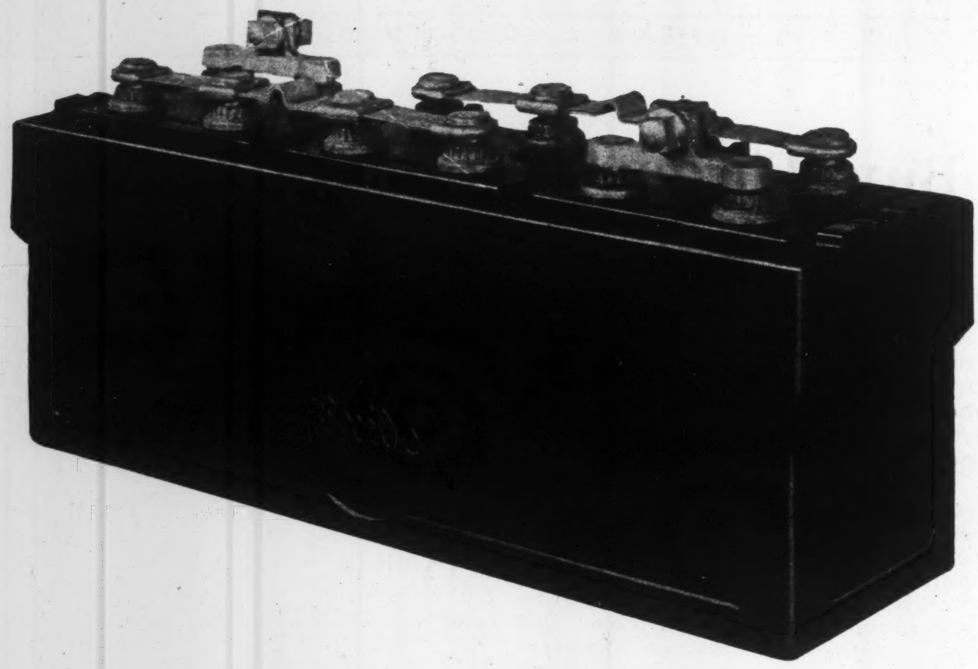

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In the News:

A TENTATIVE ALLOTMENT of $200,000,000 for grade-crossing elimination from the Emergency Relief Appropriation was announced by President Roosevelt on April 12. Definite information as to how the money is to be spent is lacking, but the President indicated that it would be under the direction of the U. S. Bureau of Public Roads. Work close to the large centers of population is to be favored. Railroads are to be relieved of paying the share normally assessed against them in such work.

MAYORS OF MANY CITIES, meeting with the President on April 11, urged that expenditures for the $800,000,000 set aside for relief work be spent in urban centers where unemployment is greatest and where the normal agencies are hard pressed to find money to carry forward useful projects.

PROTESTS against the proposed Eudora floodway in the revised Mississippi River flood-control plan have become so widespread that it is now expected that the committee on flood control of the House of Representatives will propose the elimination of this floodway from the plan to be approved by Congress.

MAINE HAS PASSED A LAW requiring the registration of engineers, bringing the total number of states having such laws up to 31. Maine is the first state in New England to adopt a registration law. One has been proposed in Connecticut but has not obtained sufficient support.

THE NEW YORK STATE LEGISLATURE has passed an amendment to the labor law creating an unemployment fund. It calls for contributions by employers of 3 per cent of their payroll. Provision is made for special consideration to be given to seasonal employment, as in some elements of the construction industry.

IN ABANDONING ITS $12,500,000 slum-clearance project on Chicago's West Side, PWA has made good its threat against any attempts to unload land on the federal government at more than its present fair market value.

THE PRESIDENT has accepted the resignation of James A. Moffett, Federal Housing Administrator, who wishes to return to private business.

In This Issue:

EXPERIENCE in concreting seven locks and a dam in the upper Mississippi canalization program demonstrated the efficacy of modern construction plant and concrete technology. A tabulation of procedure and performance covers the placing of 615,000 cu.yd. of concrete.

A PROPOSED DESIGN for rebuilding Brooklyn Bridge to meet modern traffic demands involves the use of a new double-deck roadway and stiffening trusses made of structural aluminum. The old towers and cables would be retained.

SUBWAY BUILDING means sewer rebuilding on a large scale. New York work on the new Independent Subway System required reconstruction of 60 miles of sewer along 55 miles of track. The general and special planning involved in handling the sewer work is outlined by engineers who were closely identified with it.

BY USING RELIEF LABOR AND FUNDS, Ithaca, N. Y., rejuvenated its run-down airport, extended the field and built a new hangar, runways and drainage system. A model small-city layout was produced for $103,000.

WIDENING WOODWARD AVE. IN DETROIT is one of the premier civic improvement jobs in the country. During the past two years a five-track railroad grade-separation has been built and 3,500 ft. of 90-ft.-wide pavement laid in the new 120-ft. right-of-way. The latter work illustrates the most modern practice in constructing sheet asphalt on a concrete base.

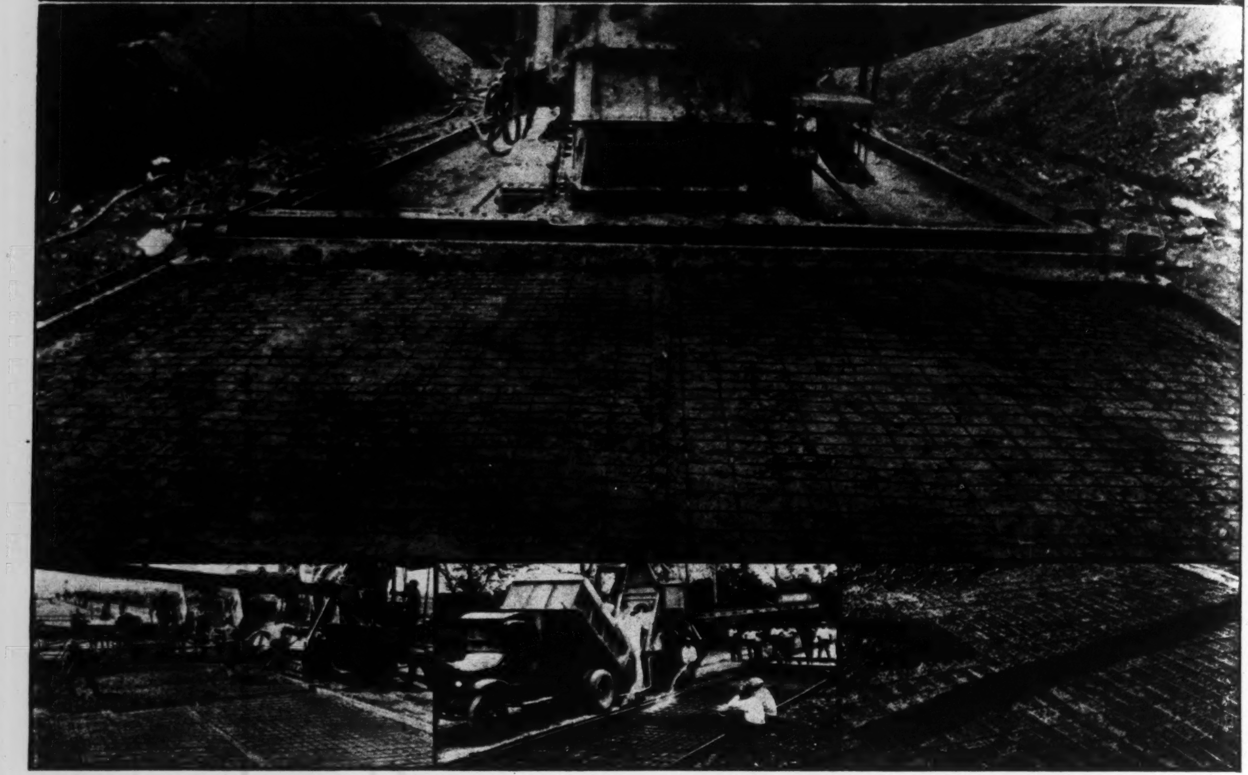
Have You Been Reading John F. Stevens' Recollections?

If so, you will not want to miss next week's installment in which the scene shifts from early days on the Canadian Pacific to railroading in frontier Michigan and Wisconsin.

If you missed the first three stories, look up your *News-Records* for March 21, March 28 and April 11.

Read "Recollections" to your family and your friends. They paint engineering at its rough-and-ready best.

POSITIVE CRACK CONTROL



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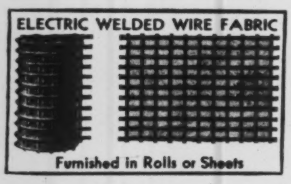

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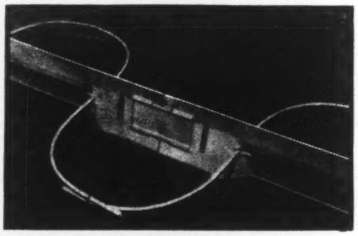

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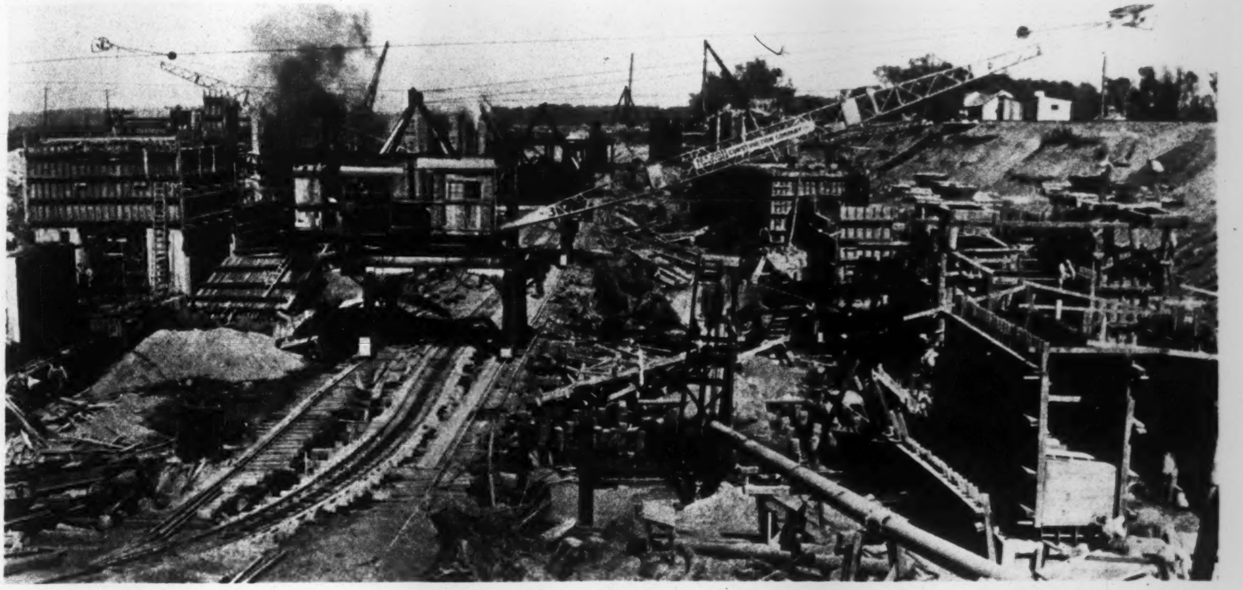


FIG. 1—PLACING LOCK CONCRETE with traveling derricks on Lock 18 of the upper Mississippi slack-water navigation improvement.

Concreting Plant and Methods on Mississippi River Locks

Dimension and tabulation of procedure and performance in placing 615,000 cu.yd. of concrete in seven locks in Rock Island engineer district

By J. B. Alexander and Sam Comess

Engineer and District Concrete Technician, Respectively; U. S. Engineer Office, Rock Island District, Rock Island, Ill.

THE CANALIZATION of the upper Mississippi River between St. Louis, Mo., and St. Paul, Minn., progressed rapidly during 1934, with thirteen locks and three dams under active construction. Seven locks and one dam are in the Rock Island District, which extends from the mouth of the Wisconsin River to Clarksville, a distance of 366 miles. A total of 647,000 cu.yd. of concrete is required in the construction of the eight projects, and about 615,000 cu.yd. were placed between April 15 and Dec. 31, 1934. This article is a review of plant and procedure employed and a summary of progress and performance in mixing and placing this concrete.

Design of concrete mix

The concrete was designed under a revised specification issued in September, 1933, written for the purpose of reducing the heat of hydration by a reduction in the cement content of the batch and by requiring a coarse-ground cement. The specification required a minimum of 4½ bags of cement, 15 per cent of which should be retained on the 200-mesh sieve. The water content of the mix was fixed at 6½ gal. per sack. Coarse aggregate up to 6-in. maximum size was permitted. A control of the grading was provided for in the requirement that two bins be used; when the maximum size of aggregate was 1½ or 2 in., the division of grading was set at one-half the minimum, or ¾ and 1 in., respectively. Three bins were required when the maximum size exceeded 2 in.

The contractors on all projects elected to use aggregates that would require no more than two sizes because of the difficulty of obtaining aggregates above the 2-in. size and the expense of providing more than two bins. On two of the structures washed bank gravel of 1½-in. maximum size was used. Crushed limestone was used on the other six structures, and the maximum size of the crushed-stone aggregate was 2 in. in every case. All coarse aggregate was subjected to sodium-sulphate test and required to withstand five cycles without appreciable disintegration.

The specifications for the fine aggregate required that between 10 and 25 per cent must pass the No. 50 screen. Where sand with the required amount

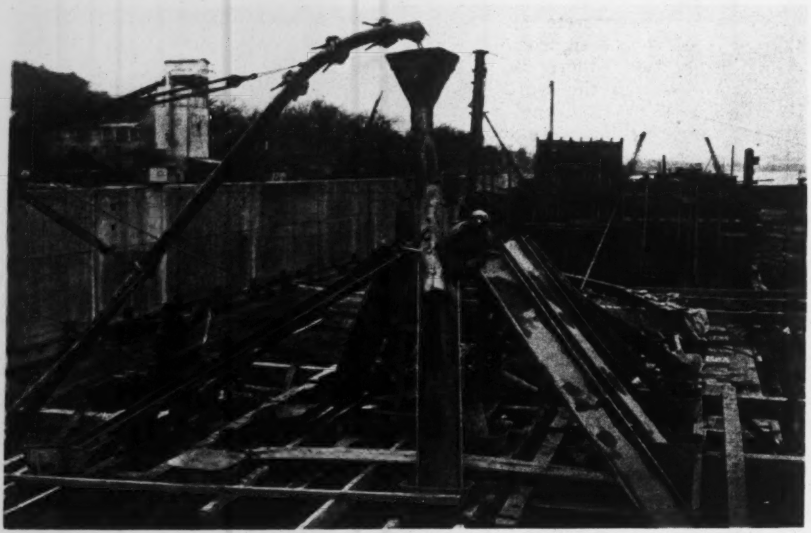


FIG. 2—PUMPING CONCRETE on Lock 12; note radial chutes and bootleg arrangement for wide distribution required by dry concrete.

of fines was not available, the use of a cementitous or puzzolanic admixture was permitted, to make up the deficiency. The use of additional cement for this purpose was not permitted. The contractors on three of the lock projects provided extra bins in their batching plants for fine sand, which was added to the batch in the proper proportion to make up the deficiency of fines in the sand from the principal source of supply. Puzzolanic admixtures were used to make up the deficiency of fines in the sand at the dam and two locks. The contractors on the remaining two lock projects were successful in finding a supply of sand that met the provisions of the specifications. The use of admixtures did not give the most workable mix, chiefly because this material was added only in sufficient quantities to meet minimum requirements.

In Table I are shown the proportions, slump and compression strength obtained for concrete on the several contracts.

Mixing and transporting

The specifications required the use of two mixing units on each job. The time of mixing was fixed at 1½ min. for units up to and including those of 1½-cu.yd. capacity and at 2 min, for units of greater capacity. The use of weighing batchers and automatic timing devices was required. The plants at several of the projects were equipped for full automatic operation.

Bulk cement was used on all jobs. Deliveries were made to four projects by barge and to four by railroad. Pneumatic handling equipment was employed for transferring the cement from cars or barges to the storage bins at all but one project. At Lock 18, a scraper and bucket conveyor were used for this purpose. The capacities of the mixers and storage bins together with data on the batching plants are given in Table II.

Several different methods were employed in transporting and handling concrete between the mixing plant and the forms on the eight projects. At Locks 11 and 18 and Dam 20, concrete in buckets was hauled over industrial railway systems and placed in the forms by cranes; at Lock 10, 3-ton trucks were used to transport the concrete from the plant to the form, and on the four remaining projects Pumpcrete systems were used to deliver the concrete to the forms.

The height of the lock walls (from subgrade to top of wall) varies from 37 ft. at Lock 10 to 43 ft. at Lock 21. In general, the walls were placed in three lifts, and the maximum height of any continuous pour was fixed at 18 ft. The lifts were 30 ft. in length. The distribution methods at the forms were similar whether cranes or pipe lines were used in delivering the concrete.

Placing methods

The concrete in all cases was too dry to flow. Consequently, it was necessary to place each batch so that very little movement in the form would be required.

Sheet-metal form hoppers, each pro-

TABLE I COMPOSITION AND STRENGTH OF CONCRETE FOR LOCKS AND DAM IN ROCK ISLAND DISTRICT OF UPPER MISSISSIPPI NAVIGATION WORKS

Project	Mixed Dry Weight	W/C	Slump, In.	Yield Skips per Yard	Average Compression Strength for Job to Date 7-Day	28-Day
Lock 10	1–3.21—4.59	.87	1	4.59	2,290	3,723
Lock 11	1–2.99—5.33	.87	¾	4.50	2,485	4,267
Lock 12	1–2.86—5.02	.86	1	4.62	2,508	3,967
Lock 16	1–3.15—4.90	.87	¾	4.55	2,508	3,552
Lock 18	1–3.07—5.07	.87	1¼	4.50	2,873	4,338
Dam 20	1–2.65—4.96	.84	1½	4.60	2,161	3,782
Lock 21	1–2.98—5.14	.87	1	4.50	2,729	3,804
Lock 22	1–3.02—5.06	.87	1¼	4.50	2,577	3,836

TABLE II—MIXING AND BATCHING PLANTS FOR SEVEN LOCKS AND ONE DAM IN ROCK ISLAND DISTRICT, UPPER MISSISSIPPI NAVIGATION WORKS

Job	Location	Mixers		Materials Storage Cap.		Weighing Bachers	Weighing System			Time of Mix Min.
		No.	Cap.	Aggregate in Tons	Cement Bbl.			Cement	Water	
Lock 10	Guttenberg, Ia.	2	28S	200	150	3-compartment aggr. weighing batcher.	Multiple-beam scales	Dial automatic scale	Automatic scale	1½
Lock 11	Dubuque, Ia.	2	40S	250	400	4-compartment aggr. weighing batcher.	Hand-oper. dial scales	Automatic beam scale	Automatic scale	1½
Lock 12	Bellevue, Ia.	2	56S	300	200	4-compartment aggr. weighing batcher	Multiple-beam scale, hand-oper.	Automatic scale	Automatic scale	2
Lock 16	Muscatine, Ia.	2	28S	180	200	3-compartment aggr. weighing batcher	Hand-oper. dial scales	Automatic beam scale	Automatic beam scale	1½
*Lock 18	6 miles north of Burlington, Ia. on Illinois bank of river	2	28S	100	500-bbl. bins	3-compartment weighing batcher	Hand-oper. multible-beam scales	Visible* dial scale	Hand-oper. volume tanks	1½
Dam 20	Canton, Mo	2	40S	150	300	3-compartment weighing batcher	Multiple-beam scales	Dial Automatic scale	Hand-oper. volume tanks	1½
Lock 21	Quincy, Ill.	2	40S	200	280	3-compartment aggr. weighing batcher	Automatic multiple-beam scale	Automatic scale	Automatic scale	1½
Lock 22	Saverton, Mo.	2	40S	200	280	3-compartment aggr. weighing batcher	Automatic multiple-beam scale	Automatic scale	Automatic scale	1½

*Cement weighed at cement silos and delivered in batcher boxes to mixing plant 200 ft. away by cableway.

TABLE III—TRANSPORTING AND DISTRIBUTING CONCRETE IN LOCKS AND DAMS, ROCK ISLAND DISTRICT, UPPER MISSISSIPPI NAVIGATION IMPROVEMENT. ALL CONCRETE WAS VIBRATED

Job	Methods of Transporting Concrete	Placing	Distributing
Lock 10	1½-cu. yd. bottom-dump buckets, hauled by trucks	Crane	Chutes, form-hoppers and trunk
Lock 11	1½-cu. yd. bottom-dump buckets, Industrial railway on 3-ft-gage track	Cranes	Form-hoppers
Lock 12	Transported by Pumpcrete system	Pipe line	Chutes and form-hoppers
Lock 16	Transported by Pumpcrete system	Pipe line	Chutes and form-hoppers
Lock 18	1½-cu. yd. bottom-dump buckets, hauled by industrial railway	Whirleys on gantry	Form-hoppers and trunks
Dam 20	1-cu. yd. bottom-dump buckets, hauled by industrial railway	Cranes	Form-hoppers
Lock 21	Transported by Pumpcrete system	Pipe line	Counterbalanced chutes and form-hoppers
Lock 22	Transported by Pumpcrete system	Pipe line	Counterbalanced chutes and form-hoppers

vided with lengths of flexible chutes or downspouts, were set at various locations over the top of the forms. Usually nine to twelve hoppers were required to provide a proper distribution of the concrete in the forms.

Where cranes and buckets were employed, the buckets were spotted directly over a form hopper, and the downspouts provided sufficient flexibility to distribute the concrete over an area about 5 ft. in radius. Where the concrete was delivered to the form by a pipe line, the discharge pipe was carried 6 to 8 ft. above the top of the form, and either a counterbalanced chute was suspended from the end of the pipe, or a swivel hopper set on standards was used to direct the flow of the concrete to the several form hoppers. In Table III the kind of equipment used in handling and placing concrete on each project is shown.

After the concrete was deposited in the form, it was compacted by high-frequency internal vibrators. Two of the 75-lb. pineapple type were used to vibrate the main body of the concrete. These heavy vibrators were supplemented by lighter flexible shaft machines, which were used principally along the form faces and to reach otherwise inaccessible locations. Spading was also employed along the form faces to insure dense finished surfaces.

The number of men required in the form to place the concrete properly varied from eleven to fifteen, depending upon the efficiency of the distribution system. From five to seven of these were employed in handling the vibrators, two men spotted and dumped the buckets into the form hoppers, two men were engaged in spading along the form faces and from two to four men were required to shovel concrete into locations out of reach of the downspouts or in bailing free water that collected on the surface of the concrete.

Although the concrete on each of the projects was designed under the same specifications, there were noticeable differences in the workability of the fresh concrete from one job to another. The variations were attributable to a difference in the physical characteristics of the materials entering the mix rather than to the methods of design and control, which were uniform throughout the district. Because of the variable factors, it was found that no uniform procedure in vibrating and spading could be applied to all projects. Both the interval of time required for vibrating at any given point and the distance between points was varied to suit conditions.

The greatest difficulty encountered in satisfactorily placing concrete was that of bleeding, or the accumulation of free water on the surface of the concrete. This was not a general condition but was confined to specific projects where the physical characteristics of the materials used were such as to prevent them from absorbing all of the water that it was necessary to use to produce a workable mix. A reduction in the amount of mixing water, in an attempt to correct the bleeding, resulted in an unworkable concrete. When this condition was especially bad, men were required to bail the water off in buckets and dispose of it outside the form. The principal defect in the finished concrete where this condition prevailed was that of sand streaking on the vertical wall faces. Though the sand streaks were only superficial imperfections, they presented a very unsightly appearance. Subsequent tests on percentage loss by

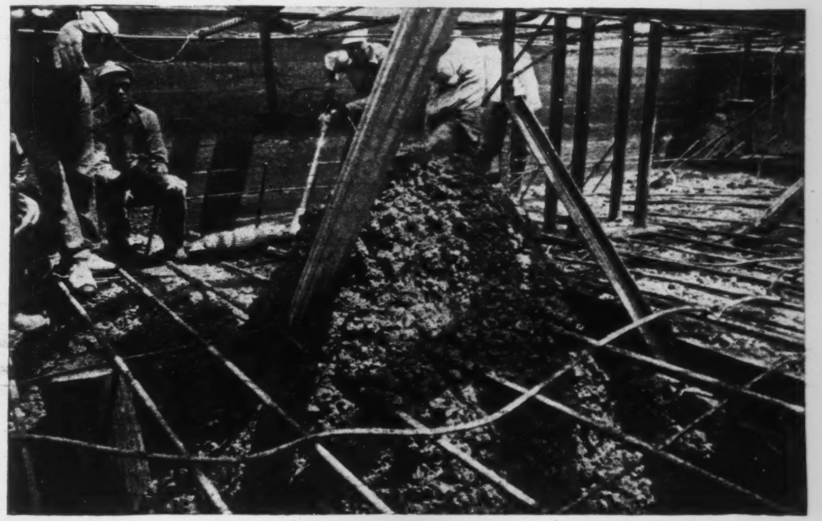


FIG. 3—CONSISTENCY OF CONCRETE as deposited by pumping at Lock 16. Vibrators speedily settled the pile into the mass.

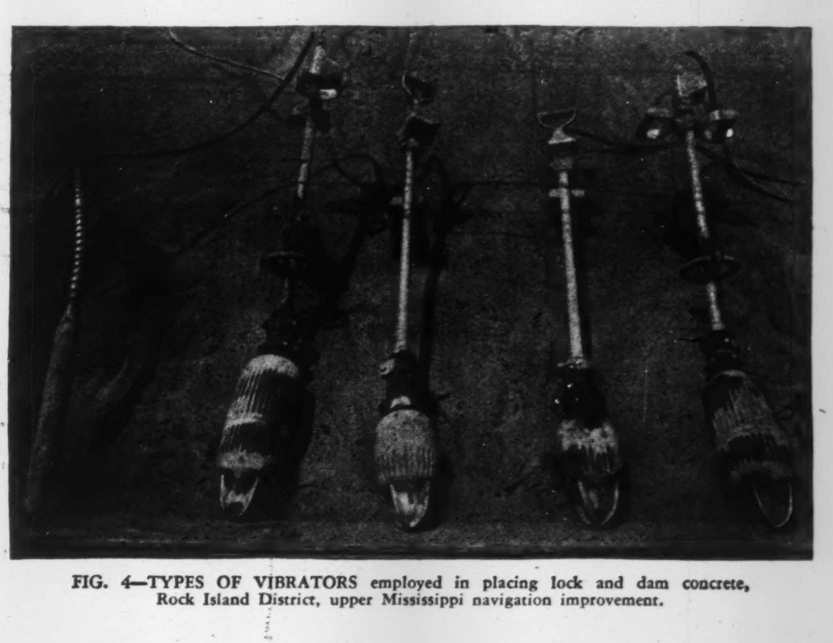


FIG. 4—TYPES OF VIBRATORS employed in placing lock and dam concrete, Rock Island District, upper Mississippi navigation improvement.

abrasion and freezing and thawing show that the body of this concrete is not inferior. The test samples for this purpose were taken from cores removed from the structure.

The depth of each horizontal layer of concrete placed in the form was limited to 18 in. It was found that this depth could on some projects be increased to 24 in., or an even greater depth, with very satisfactory results, while on others the depth had to be reduced to about 12 in.

Three test cylinders 6x12 in., were made during the placing of each lift. The cylinders were cured in water at 70 deg. F. at the site of the work and were subsequently hauled to the district laboratory at Rock Island for compression tests made at intervals of 7,28 and 90 days. Tests on loss by abrasion and freezing and thawing were also performed.

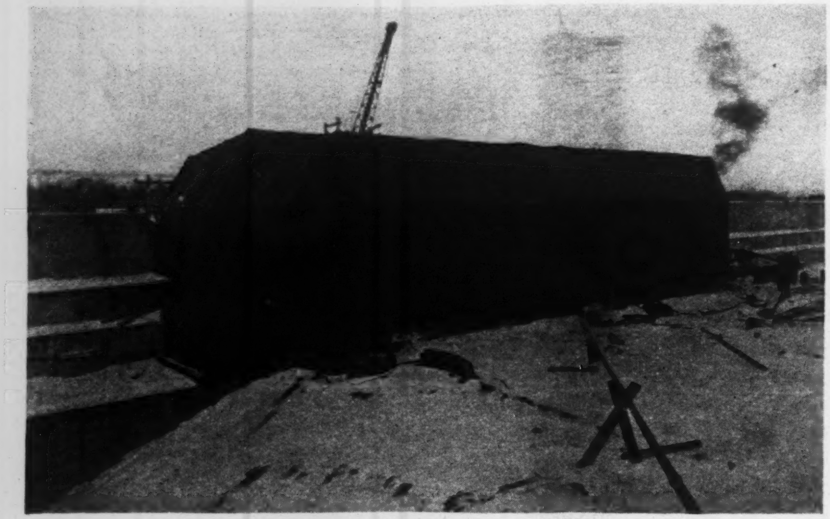


FIG. 5—COLD-WEATHER PROTECTION of concrete for Lock 10. On most of of the work winter concreting was avoided.

The average plant output for months of peak production and the average hourly output for all concrete placed up to Jan. 1, 1935, are shown in Table IV. In preparing this table, all plant delays of less than 5-min. duration were not included in computing average output. On two projects the average output for the job was greater than that of the peak month. This is explained by the fact that the large monthly output was accomplished by continuous operation rather than an increased average hourly production.

TABLE IV—PRODUCTION RATES IN CONCRETING LOCKS AND DAM, ROCK ISLAND DISTRICT, UPPER MISSISSIPPI NAVIGATION WORKS

Job.	Total Concrete, Cu. Yd.	Peak Month, Cu. Yd.	Hourly Rate During Peak Months, Actual Pouring Time, Cu. Yd.	Hourly Average Rate for Job, Cu. Yd.
Lock 10	82,274	23,333 Oct.	43.50	35.79
Lock 11	84,984	25,755 Oct.	40.0	36.2
Lock 12	81,518	19,351 Oct.	26.63	25.8
Lock 16	74,729	16,500 Sept.	30.1	31.2
Lock 18	80,845	21,288 Oct.	36.7	34.0
Dam 20	71,656	15,063 Nov.	46.18	36.8
Lock 21	90,839	21,109 Oct.	38.0	36.8
Lock 22	77,800	22,931 Oct.	27.4	29.5

Note: Delays of 5 min. or less not included in computing average rate of output.

Curing and winter work

Continuous wet-curing for a period of fourteen days was required by the specifications. Several methods were used, but that which proved the most satisfactory as well as the most economical was the installation of perforated galvanized pipes along both sides at the top of each lift. A continuous spray from pipes properly located kept the entire top and faces of the monolith, thoroughly covered with a film of water. Some difficulty was experienced with the perforations becoming clogged with silt or sand, and the work, therefore, had to be watched closely. Another objectionable feature encountered was the occurrence of iron oxide in the water used for curing, which produced unsightly stains on the faces of the walls. At one project where this condition was particularly bad, the concrete was cured by draping the monoliths with burlap, which was thoroughly saturated intermittently by sprinkling with a garden hose. This method was not as satisfactory as that of continuous spraying because the wet burlap could not be kept in close contact with the concrete surfaces, which occasionally dried out if not carefully watched.

When the temperature was 35 deg. or below, special precautions were required in handling and curing the concrete. It was required that the concrete be delivered to the form at a temperature between 50 and 100 deg. F. and that the ambient temperature at the form be maintained at 70 to 100 deg. F. for a period of five days following the completion of each lift.

It was found that for temperatures between 25 and 35 deg. F. it was only necessary to heat the mixing water to impart sufficient heat to the batch to meet the specifications. Curing between these limits of temperature was accomplished by draping the forms with tarpaulins under which water jacketed salamanders were placed, and the forms were kept wet with spray pipes. When the ambient temperature was below 25 deg. F., the aggregate was heated by using live-steam coils at the discharge of the batching hopper, in addition to heating the mixing water. It was occasionally necessary to use steam jets in the stockpiles to thaw the sand and gravel.

Protection and curing of concrete in the forms when the temperature was below 25 deg. F. were accomplished by steam pipes. These pipes were perforated to permit the discharge of live steam, which furnished heat for protection and moisture for curing operations.

A comparatively small yardage of concrete was placed during the winter months, as the work at most projects was quite well advanced before the advent of cold weather. Because of the condition of the work, it was possible to select periods of reasonably mild weather even during the winter season to place concrete. Practically no concrete was placed when the temperature was below 10 deg. F.

Engineering direction

The construction of the locks and dam in the Rock Island District is being performed by contract under the direction of Major R. A. Wheeler, Corps of Engineers, U. S. Army, District Engineer, with Captain R. E. Coughlin as officer in charge of the general engineering division. E. E. Abbott, senior engineer, is in direct supervision of the planning section, which prepares the plans and specifications and supervises the layout and inspection of contract work.

Another Conservancy Project Discussed in Ohio

Another Ohio conservancy project, similar to the $34,000,000 Muskingum Valley development and the subsequent $36,000,000 Scioto-Sandusky program now definitely proposed, is being contemplated for the Hocking Valley in the same state. Engineers of the PWA, according to reports, have made preliminary investigations in the counties comprising the Hocking Valley, following the request of several large cities in the area that the federal government assist in the development.

Aluminum Trusses and Floor for Brooklyn Bridge

Proposed plan for reconstruction of famous suspension bridge contemplates a new suspended structure providing twelve lanes of vehicular traffic on two decks without increasing present dead loads—Existing towers, cables and anchorages to be retained

Underwood & Underwood

PICTURESQUE but antiquated Brooklyn Bridge over the East River at New York must sooner or later be rebuilt or replaced. The latest proposal retains the old towers and cables by rebuilding the deck and stiffening trusses in structural aluminum.

A PLAN for rebuilding the famous Brooklyn Bridge in New York by retaining the present anchorages, towers and main cables and suspending therefrom new stiffening trusses and a new floor fabricated from structural aluminum shapes and plates has been developed and proposed to the city by D. B. Steinman, consulting engineer, and by the Aluminum Company of America. The new design eliminates the picturesque but inefficient diagonal stays of the old bridge, and in other ways incorporates details that bring the structure up to modern standards. At an estimated cost of $6,250,000 (with $2,000,000 additional for approaches) the proposed plan of reconstruction will provide twelve 10-ft. lanes for vehicular traffic on two decks, six on each deck. The present cross-section of the bridge accommodates on one deck two rapid-transit tracks, two streetcar tracks and two vehicle lanes; vehicles may also run in the street car lanes. The new design is based on unrestricted use of vehicles up to 25-ton trucks, while at present all commercial traffic, with the exception of mail trucks, is barred from the bridge. By using aluminum, the total dead load on the bridge will not be increased.

The advisability of reconstructing the Brooklyn Bridge has long been recognized. More than 30 years ago Gustav Lindenthal, then commissioner of bridges of the city, presented a plan saying, "The present structure was never intended and dimensioned for the traffic it has to bear now. The suspended structure, from anchorage to anchorage about 3,600 ft. long, is in a worn-out and weakened condition, requiring constant and expensive repairs to keep it safe. The rebuilding of the bridge has become imperative, but must necessarily be deferred until the Manhattan Bridge shall have been completed." At present the Manhattan Bridge is carrying much of the commercial traffic that should and would logically use the Brooklyn Bridge if its capacity permitted.

In spite of high maintenance costs and the recognized need for major reconstruction, money has never been available, and the Brooklyn Bridge has remained in service, without substantial improvement, for 52 years. The increased East River traffic referred to by Mr. Lindenthal 30 years ago has since multiplied many times, and at present not only the Brooklyn Bridge but the Manhattan, Williamsburg and Queensboro Bridges over the East River are in need of repairs.

Numerous civic organizations have urged reconstruction of the Brooklyn Bridge, recommending increased vehicular capacity, reduction or elimination of rapid-transit facilities and removal of the unsightly terminals and elevated structures at the two ends of the bridge. The last-named change is about to be realized on the Manhattan end of the bridge; the Department of Plant and Structures has already announced that sometime in April the removal of the elevated extension over Park Row and part of City Hall Park will be started as part of the plan to improve the appearance of City Hall Park. The information that follows is abstracted from the report that accompanied Dr. Steinman's design. It is devoted exclusively to the main bridge, although a solution for the difficult problem of the approaches forms an important part of the original report.

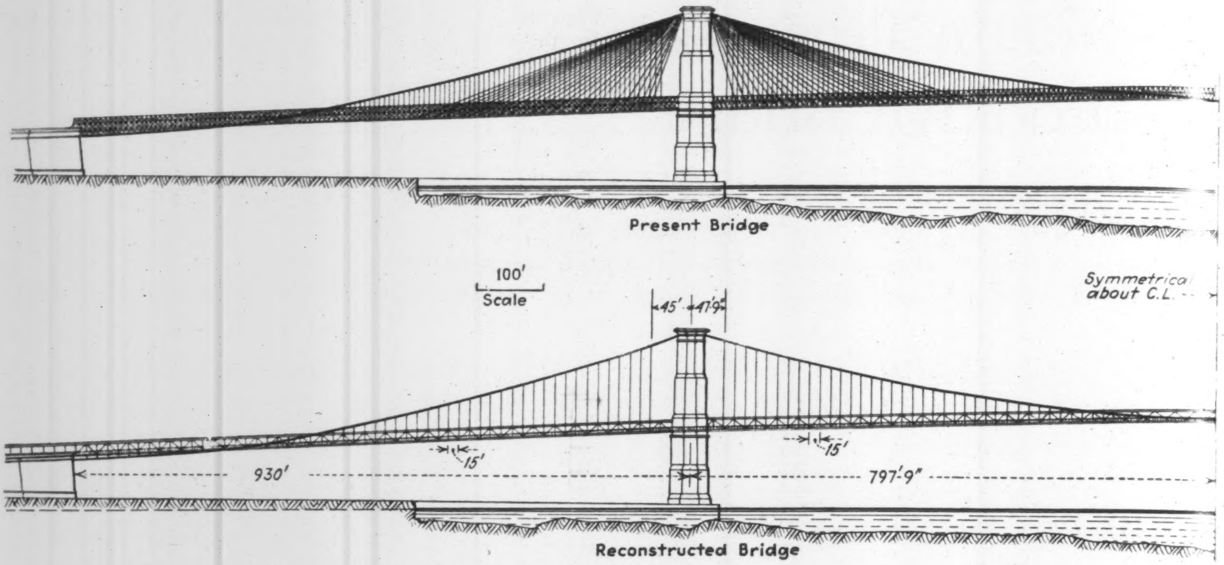
Present and proposed cross-sections

The present cross-section provides but two clear lanes for vehicular traffic. The roadway is a combination of steel and timber, paved with wood blocks. The floor beams are spaced 7½ ft. on centers and are of latticed construction. There are four cables and six stiffening stresses, four of which are deep and two shallow. The two shallow trusses are adjacent to the outer cables; two deep trusses are adjacent to the inner cables; and the remaining two deep trusses receive their loads only indirectly through their floor-beam reactions. Consequently, the load distribution to the four cables and the six trusses is irregular and uncertain.

On the proposed new suspended structure (to be fabricated of rolled structural shapes of aluminum alloy 27ST assembled with steel rivets) floor beams are spaced 15 ft. on centers and are of plate-girder construction. The structure is designed for vehicular traffic only and provides twelve 10-ft. lanes. The floor is of "battledeck" construction (stiffened plate panels) similar to that used on the Smithfield St. Bridge in Pittsburgh. There are four stiffening trusses of uniform depth, each adjacent to a cable.

The diagonal stays, which are, next to the masonry towers, the most distinguishing characteristic of the old Brooklyn Bridge, would be removed, on the ground that their use is obsolete and their action highly indeterminate. Frequent breakages that have occurred indicate the difficulties inherent in their adjustment and maintenance.

The present stiffening truss is a double-tension (quadruple-intersection) system, with pin joints. Shearing stress divides between two tension mem-

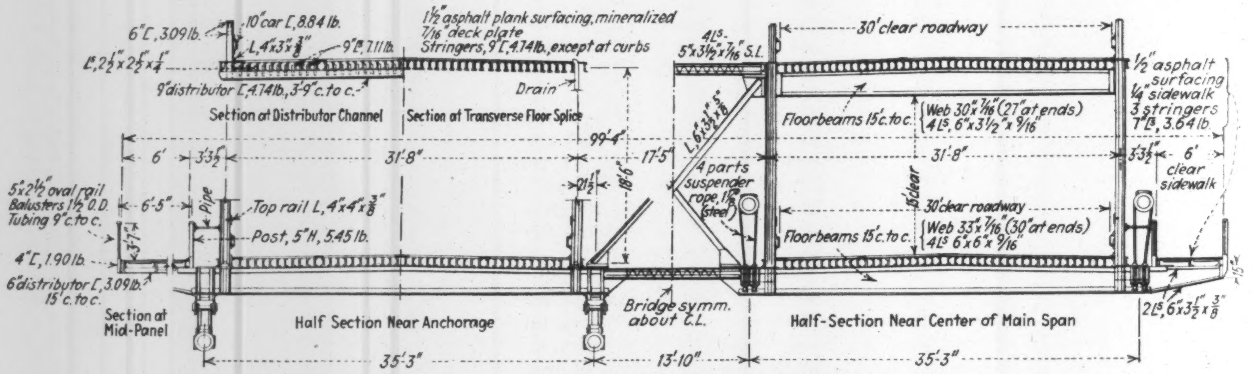

Present Bridge
100'
Scale
45'
47'9"
Symmetrical about C.L.
15'
15'
930'
797'-9"
Reconstructed Bridge

PROPOSED PLAN for reconstructed Brooklyn Bridge replaces the characteristic diagonal stays and old-time trusses with vertical suspenders and Warren type trusses.

bers, stretching them and loosening the counter-members. This arrangement results in a noisy rattling structure, complicated in detail and troublesome in maintenance, due to pin repair. The proposed stiffening truss is of riveted Warren type, such as is used exclusively in all modern suspension bridges.

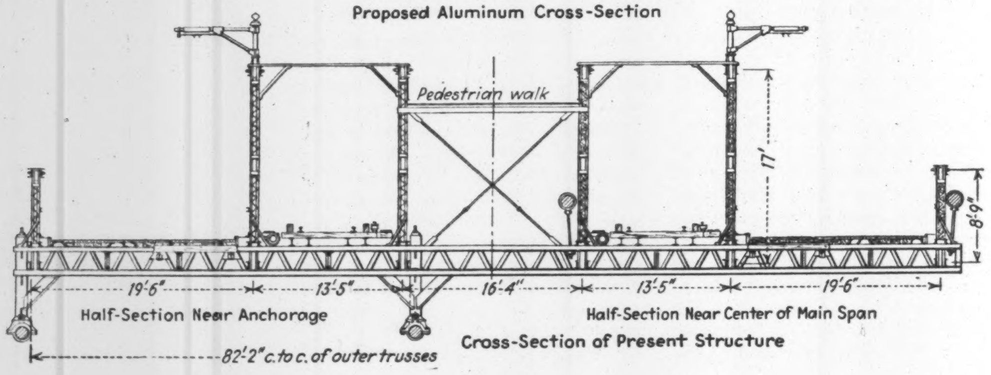
Another disadvantage of the present stiffening truss is that it is fixed at the towers and hinged at the center of each suspended span, an arrangement that has long been obsolete. Since all expansion takes place at the center hinges, trouble has occurred because relative motion between cable and truss is concentrated at the point where the suspenders are shortest, with consequent danger of breakage of these suspenders. Furthermore, a hinge at the center reduces the lateral stiffness of the structure against wind, and produces peaks in the grade line of the truss, inducing excessive secondary bending stresses in the cable.

The proposed stiffening trusses are two-hinged, with the hinges located at the towers. In the main span the truss would be fixed to the cable at mid-span, where the suspenders are shortest; relative expansion would be toward the towers, where the suspenders are longest. In the side spans the stiffening truss would be fastened to the cable where the latter intersects the


6" [, 3.09 lb.
10" car [, 8.84 lb.
L, 4"x3"x3/8"
9" [, 7.11 lb.
L, 2½"x2½"x¼"
9" distributor [, 4.74 lb., 3'-9" c. to c.
1½" asphalt plank surfacing, mineralized
7/16" deck plate
Stringers, 9" [, 4.74 lb., except at curbs
Drain
Section at Distributor Channel
Section at Transverse Floor Splice
99'-4"
6'
3'3½"
31'-8"
17'-5"
18'-6"
21½"
5"x2½" oval rail
Balusters 1½" O.D.
Tubing 9" c. to c.
6'-5"
Pipe
Top rail L, 4"x4"x3/8"
Post, 5" H, 5.45 lb.
3'-7"
4" [, 1.90 lb.
6" distributor [, 3.09 lb.
15' c. to c.
Section at Mid-Panel
Half Section Near Anchorage
35'-3"
13'-10"
35'-3"
Bridge symm. about C.L.
4 Ls- 5"x3½"x7/16" S.L.
L, 6"x3½"x5/8"
4 parts suspender rope, 1⅞" (steel)
30' clear roadway
Floorbeams 15' c. to c.
Web 30"x7/16" (27" at ends)
4 Ls, 6"x3½"x9/16"
15' clear
30' clear roadway
Floorbeams 15' c. to c.
Web 33"x7/16" (30" at ends)
4 Ls 6"x6"x9/16"
½" asphalt surfacing
¼" sidewalk
3 stringers
7" [s, 3.64 lb.
3'3½"
6' clear sidewalk
15"
2 Ls, 6"x3½"x3/8"
Half-Section Near Center of Main Span

Proposed Aluminum Cross-Section

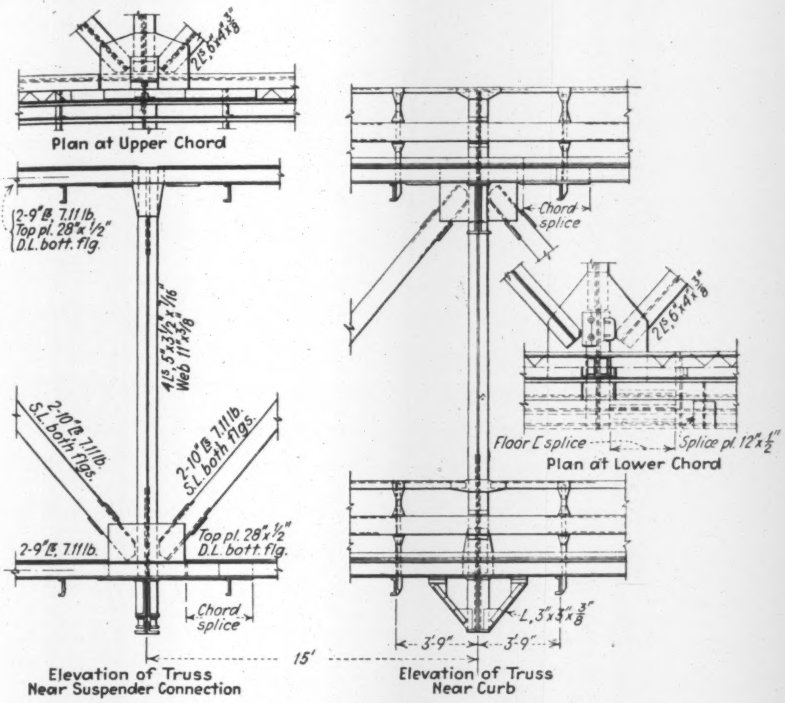
ALL MATERIAL in the proposed new cross-section for the Brooklyn Bridge is aluminum alloy, except the rivets. Four 30-ft. roadways are contemplated in place of the present two 20-ft. roadways. Streetcars and trains are eliminated.


Pedestrian walk
17'
8'-9"
19'-6"
13'-5"
16'-4"
13'-5"
19'-6"
Half-Section Near Anchorage
Half-Section Near Center of Main Span
82'-2" c. to c. of outer trusses

Cross-Section of Present Structure

lower chord of the truss, with expansion toward the tower and anchorage, where suspenders and cable struts respectively are longest. The absence of hinges at mid-span will eliminate from the trusses, roadway and cables the objectionable horizontal and vertical cusps which are now caused by wind, live load and temperature.

The present dead load of the Brooklyn Bridge is about 8,400 lb. per linear-foot. The dead load of the proposed structure would be practically the same, and since it would be distributed equally to the four cables, the maximum cable stress would be less than in the present structure.



ELEVATION AND DETAILS of aluminum-alloy stiffening truss proposed for Brooklyn Bridge.

Safety of present towers and anchorages

A careful investigation of the strength and adequacy of the existing towers and anchorages was made. Although the present bridge was designed to permit the saddles to move on rollers on top of the towers, the rollers have been inoperative for many decades, producing the condition of saddles fixed to the towers. Because of the great rigidity of the broad masonry towers, they have thus been forced to act as anchorages for unbalanced cable pulls caused by live load and temperature. Although the resulting overturning moments might be avoided by restoring the rollers to operation, fixity of the saddle was recognized as having an important advantage in holding the span lengths invariable, thus reducing stresses and vertical deflections in the stiffening trusses and permitting considerable economy in the design of the suspended structure. Investigation of the masonry towers, to determine whether fixed saddles would give rise to dangerous stresses in the tower masonry, revealed that under maximum loading the maximum intensity of pressure occurs slightly above mid-height of the tower and is about 50 tons per sq.ft., or 695 lb. per sq.in., which was considered to be a permissible safe load for the first-class ashlar masonry with thin mortar joints of which the towers are built. The proposed design, therefore, contemplates the retention of the fixed saddles on the existing towers.

Since the total cable pull acting on the anchorages will not be increased by the load of the new structure, except possibly by a slight amount under an extreme concentration of live load, the anchorages were considered safe to serve the proposed structure without reinforcement. For the Brooklyn anchorage, the lighter of the two, a maximum toe pressure of 6.76 tons per sq.ft. and a minimum heel pressure of 0.84 tons per sq.ft. would be obtained with the side span fully loaded at low temperature. These pressures, which have existed for over half a century, were considered to be safe.

Design loadings and stresses

The proposed structure is designed for unrestricted modern highway loading: roadway surface, H25 per lane; floor beams, three lanes of H20 for moment and one lane of H25 plus two lanes of H10 for shear; sidewalks, 100 lb. per sq.ft.; stiffening trusses and cables, 3,444 lb. per linear-foot of bridge, made up of one 60-ft. deck of heavy traffic, at 40 lb. per sq.ft., and one 60-ft. deck of light traffic, at 15 lb. per sq.ft., plus sidewalk loads. An H25 loading consists of a 25-ton truck (load divided 1:4 between front and rear axle) followed and preceded at 20-ft. intervals by $18\frac{3}{4}$-ton trucks.

The aluminum alloy, *27ST*, has an ultimate strength of 58,000-66,000 lb. per sq.in., a minimum elastic limit of 45,000 per sq.in. and a modulus of elasticity of 10,000,000. A basic unit stress of *22*,000 lb. per sq.in. in tension was used in the design. The design stresses for compression are based on a factor of safety of *2* for given l/r ratios, with a maximum permissible stress of 18,000 per sq.in.

Because of the lower value of E for the aluminum alloy, it was considered proper and conservative to apply a factor of 0.6 to the usual steel impact formulas when applying them to the proposed structure. The impact formula used in the design of the floor system was

$$I = 0.60 \times \frac{50}{L + 125}$$

when L is length of load in feet to give maximum stress.

New stiffening trusses and floor

The proposed floor system is of battledeck construction with floor beams spaced 15 ft. c. to c. The longitudinal beams are channels spaced 8 in. back to back, seated on the top flanges of the floor beams. The floor plate, 7/16 in. thick, is riveted to the longitudinal channels and acts in conjunction with the latter to resist stress. Transverse distributor channels are placed under the longitudinal floor channels at intervals of 3 ft. 9 in., resulting in a floor in all respects the same as was used in 1933 on the Smithfield St. Bridge in Pittsburgh (*ENR*, Nov. *23*, 1933, p. 611).

Due to its construction, the floor will participate in the stiffening-truss stresses and thus lead to economy of chord sections and simplicity of detail. The participation is accomplished effectively by omitting expansion joints in the floor and splicing the floor plates to the cover-plates on the upper flanges of the stiffening-truss chords. Omission of expansion joints in the floor also permits full continuity of floor construction with corresponding increase in economy and stiffness.

In computing stresses in the stiffening trusses, all longitudinal channels, the floor plate and the truss chords were assumed to act together in stress resistance. Chord stresses from stiffening-truss bending were accordingly considered to be distributed uniformly over this material. The floor material also was considered to act in unison with the chords in taking wind stress.

Cables and accessories

As stated, the existing cables will be utilized, since under maximum load conditions the unit stress is only 57,500 lb. per sq.in. This is well within design values, the minimum elastic limit and ultmate strength of the cable wire being 120,000 and 180,000 lb. per sq.in. respectively.

Suspenders for the proposed structure consist of four parts of 1⅛-in. galvanized steel bridge cable spaced 15 ft. c. to c. They are looped over the cable bands and attached to the floor beams by steel socket castings bearing on stiffener angles. The load at each panel point is 131,600 lb., including dead load, live load and impact, which may be compared with an ultimate strength of 430,000 lb. for the four parts of 1⅛-in. bridge cable.

Conventional cast-steel cable bands would be used. The old cables would be rewrapped with No. 9 double-galvanized soft iron wire.

Rigidity of proposed design

Because of the low modulus of elasticity for aluminum, especial study was devoted to the rigidity of the proposed structure as measured by deflections. Under full-span loading with 860 lb. per foot of cable (estimated live load) at highest temperature, the calculated deflection at the center of the main span in the present structure was found to be 4.75 ft. Under the same loading and temperature, the corresponding figure for the aluminum design proved to be only 3.61 ft., indicating very satisfactory rigidity. It is to be noted that these figures are merely for calculated deflections, which are always much greater than actual deflections of a structure.

Satisfactory rigidity was also indicated by a comparison of calculated change in gradient. Under full loading and temperature in the present design, the maximum change of grade in the main span (occurring near the 19th diagonal stay) is 1.27 per cent. Under the same loading and temperature the maximum change in grade in the main span of the aluminum design (occurring at the tower) was found to be only 0.77 per cent.

Under a wind load of 800 lb. per linear-ft. of bridge, the main span of the proposed bridge will deflect 5.9 ft. (or 1:270) laterally at the center, according to the calculation. In the side span the lateral deflection under similar conditions will be 0.8 ft. (or 1:1160). These deflection figures indicate great lateral stiffness for the reconstructed bridge, in spite of the fact that the dead load, by virtue of the use of aluminum, is kept comparatively low.

Understressing and Overstressing on Iron and Steel

By **J. B. Kommers**
Professor of Mechanics, University of Wisconsin, Madison, Wis.

STUDIES of the effect of repeated understressing and overstressing (of the endurance limit) of iron and steel made recently at the University of Wisconsin have led to some interesting results, particularly with respect to overstressing. The endurance limit of a material is defined as the unit stress below which the material will withstand an indefinitely large number of cycles of repeated stress without failure. The tests at Wisconsin have employed small rotating-beam specimens which are subjected to completely reversed flexural stress in tension and compression. The S-N curve for a series of such tests is plotted in the accompanying diagram, using unit stress as the ordinate and the number of cycles necessary for rupture as the abscissa. The curve slopes downward to the right and usually becomes horizontal for large numbers of cycles. The unit stress corresponding to this horizontal line is called the endurance limit. For iron and steel a maximum run of 10,000,000 cycles is usually sufficient to determine the endurance limit. For some aluminum alloys a run of 100,000,000 may not be enough.

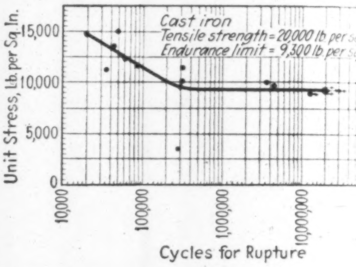
Understressing

By understressing in fatigue is meant the process of subjecting a material to repeated stresses below the endurance limit. The results of many investigators have shown that such understressing strengthens the material, so that when subsequently tested it will show a higher endurance limit than the original one. Tests made at Wisconsin on a gray cast iron showed that the most effective stress to use for such strengthening was one just below the endurance limit. The tests also showed, at least for this cast iron, that understressing produced the maximum strengthening after about 15,000,000 cycles, and, for numbers of cycles beyond this, there was no further increase in strength. The maximum increase in endurance limit obtained for this cast iron was 31 per cent for standard smooth specimens.

Later tests on three different carbon steels and a malleable cast iron indicate that these materials cannot be strengthened as much as the gray cast iron mentioned above. The amount of strengthening obtained ranged from 8 to 11 per cent for standard smooth specimens, and from 5 to 8 per cent for specimens with an imposed square notch. These results were obtained when, in the tests after understressing, a single increment of stress was imposed, to determine the new endurance limit. If, instead of a single increment, the specimen is subjected to runs of repeated stresses, using a series of small increments of stress, the above percentages of strengthening may be doubled and sometimes quadrupled.

Overstressing

By overstressing in fatigue is meant the process of subjecting a material to repeated stresses above the endurance limit. It is obvious from the accompanying diagram that any stress above the endurance limit will finally cause failure if it is repeated often enough. Since many moving parts of machines are likely to be subjected to overloads for brief periods, it is of interest to determine what the effect will be when the overstress is limited to a period of only 10,000, 20,000, or some other number of cycles. The question is: How much damage results from such overstressing?



TYPICAL endurance-test curve with stress plotted against number of cycles to failure. Arrows denote tests in which failure did not occur.

One way of measuring the damage, if any, is to determine what the new endurance limit is after the overstressing. Tests have been made on three different carbon steels and on a malleable cast iron, employing a run of 20,000 cycles. Overstress as high as 50 per cent has been applied to the malleable iron. In many cases the effect of the overstress is not nearly as serious as one might expect, and in some cases the overstress has actually caused an increase in the endurance limit. Specimens with imposed square notches have their endurance limit reduced by a smaller percentage than the standard smooth specimens.

Besides the immediate results that may be obtained from overstressing experiments, in showing the damage which brief periods of overstress may cause, it is possible that the experiments may throw light on another matter that is of considerable scientific interest. It is evident from the accompanying diagram that the region to the left of the inclined portion of the endurance curve and above the horizontal portion projected to the left is the region in which cracks are initiated. A study of the behavior of the material under overstress in this region for numbers of cycles of 20,000, 40,000, 60,000, etc., may give some clue to the number of cycles of a given stress necessary to produce the kind of damage that cannot subsequently be repaired by strengthening operations. Experiments already performed show that a specimen may be subjected to overstress for a limited number of cycles, thus producing enough damage to reduce the original endurance limit. It is then also possible by subsequent operations, at least in some cases, not only to restore the endurance limit to its original value, but even to increase it up to the value of the original overstress and beyond this overstress.

Further experiments of this nature may show that when, under certain conditions of overstressing, a material is damaged, but only sufficiently so that its strength can again be restored by subsequent operations, this is evidence that an actual crack has not been formed by the overstress. In other conditions of overstressing, when the material is damaged and it is impossible to restore its strength, this may be evidence that the overstress has initiated an actual crack.

Since at present there is comparatively little known regarding the processes which initiate cracks under fatigue action, it is hoped that a study of the behavior of material, as suggested above, may discover facts about fatigue action in general which have not been available hitherto.

Flow Over Rounded Crests —A New Formula Offered

Analysis of records of flow over rounded crest dams suggests a modified formula that simplifies calculations

By J. J. Doland
Professor of Civil Engineering, University of Illinois, Urbana, Ill.

The conventional formula for the determination of flow over rounded crest weirs, $Q=CLH^{3/2}$, is not entirely satisfactory for measuring or designing purposes on account of the variation of C for different values of H. The problem of finding an expression that would eliminate the disadvantage has attracted interest over a long period of time and continues to attract a certain type of mind. The writer became a victim, and in the course of events fell upon an interesting relation, which is offered in the hope that experimental hydraulicians will be sufficiently interested to test the principle to the extent that it may be verified or discarded.

The coefficient C for a sharp crested weir remains the same throughout a range of heads. It is also well known that the curvature of the lower nappe varies with every change of head. In the curved crest weir the curvature of the lower nappe is more or less fixed within a given range of heads by the crest shape. It is also known that the curvatures of the streamlines affect the pressure distribution throughout the jet. Therefore, it seemed reasonable to suppose that there might be a relation between curvature of the crest and the head which would have something to do with the coefficient of discharge.

Working upon this theory, the writer has spent considerable time collecting and analyzing experimental data. As a result of these studies, there appears to be evidence that the conventional formula might be modified to the following form:

$$Q = \frac{K}{(R/H)^n} L\,H^{3/2} \text{ or } Q = \frac{KL\,H^{3/2+n}}{R^n}$$

in which Q, H and L are the same as in the conventional form, K is a constant, R is the radius of curvature of the weir crest, and n is an exponent which remains constant when the water remains in contact with the rounded crest. In other words, the C of the conventional formula becomes:

$$\frac{K}{(R/H)^n}$$

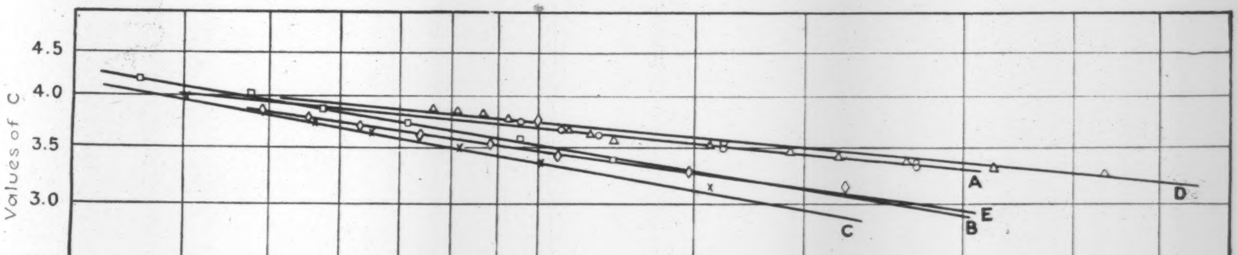
The accompanying graph shows the results of plotting the expression for C from experimental data derived from several sources. The values of R for non-circular crests were determined by carefully plotting the crest shape to a fairly large scale and passing a circle through points which seemed to indicate the most probable curvature of the lower nappe. It will be noted that the expression plots as a straight line on logarithmic paper. The slope of the line gives the value of n and the intercept on $R/H=1.0$ gives the value of K.

The graph shows only representative curves. A great many were plotted from data deemed to be reliable, with similar results. There appears to be reasonable consistency in the values of K and n for crests having similar shapes. The expression for Q as given is, of course, subject to the usual corrections for end contractions and velocity of approach.

The writer wishes to emphasize the fact that the material is offered at this time for the purpose of presenting the idea and in the hope that experimenters will bear it in mind in connection with research in this particular field. If the principle is correct, it should be of value, since it provides a direct method for determining the coefficient of discharge over a dam from a study of the crest shape.

The studies are based upon unpublished data furnished by the Bureau of Reclamation, I. A. Winter, engineer, Bureau of Reclamation, formerly of the Alabama Power Co. and others. Credit is also due T. E. Larson and B. M. Nachman, graduate students of the University of Illinois, for assembling data and making calculations.

GRAPHS OF CURVES showing results of plotting experimental data on flow over rounded crests.

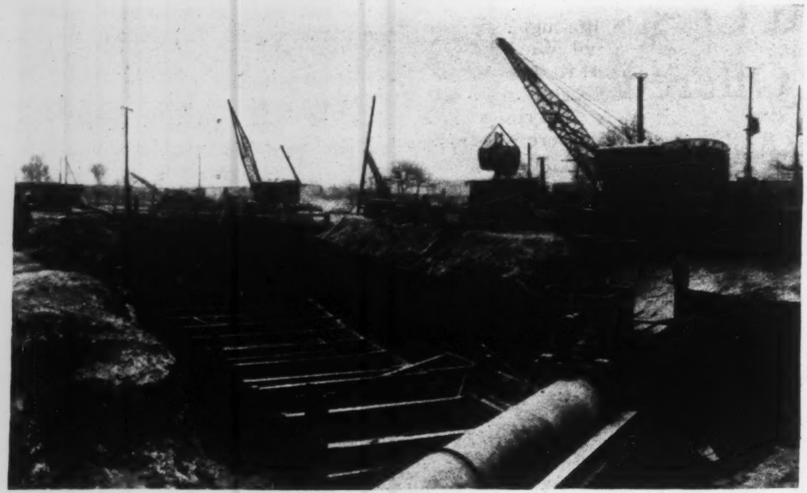


Sewer Reconstruction Problems in Subway Building

General and special planning involved in rebuilding 60 miles of sewer in recent rapid-transit subway construction in New York City

By S. D. Bleich and Alfred Brahdy
Assistant Division Engineer and Designing Engineer, Respectively; Board of Transportation, New York City

FIG. 1—EXCAVATION FOR TWO-TRACK SUBWAY, showing temporary steel flume for sewer, pump for subway sump and sediment trap.



CONSTRUCTION of the 55-mile Independent Rapid-Transit System of the city of New York was begun in 1925. It is now completed, except for 2 miles of four-track subway under Sixth Ave. in the Borough of Manhattan. Passenger service was inaugurated along the first 12 miles of this subway system on Sept. 10th, 1932, and has since been extended to include about two-thirds of the entire system, 33 miles being under operation at the present time. One of the important elements in the planning and construction of this subway was the maintenance and relocation of sewers in streets where the underground space originally occupied by the sewers was required for the subways. In connection with this work, 60 miles of new sewers had to be built at a cost of $11,000,000.

General problem

Economy in subway construction is usually obtained by keeping the subway structure as close to the street surface as is permitted by the space requirements of subsurface utilities other than sewers. This often requires that the original longitudinal sewer in the center of the street be replaced by two new sewers, one on each side of the subway (Fig. 2). Changes in the profile of a sewer that would raise the elevation of already-existing house connections are avoided, as these may result in claims for damages, even though no real injury exists. Sewers crossing the street occupied by a subway are generally blocked by the subway structure. Such a sewer must be diverted along the subway to a convenient crossing of the hydraulic grade, or else its flow is carried under and across the subway by an inverted siphon.

Careful planning of the sewers to be rebuilt is essential, first, to provide for the present and future drainage requirements of each locality, and second, to insure that sufficient space be left outside the subway and sewers for the restoration of the numerous other subsurface utilities. These conditions and limitations make the relocation of sewers one of the most difficult problems in the restoration of the various subsurface structures encountered in subway work. The difficulties are still further increased because a portion of an active existing sewer system has to be maintained while it is being rebuilt or relocated. Unless new sewers can be so planned that it is possible to build them in advance of excavating for the subway structure, it is necessary to take care of their flow by temporary flumes. These flumes generally consist of sheet-metal pipes (Fig. 3) supported by the bracing timbers of the subway structure.

The total rainfall in the New York area averages 43 in. per annum, and eight to ten times each year the rainfall exceeds 1 in. per day. The maximum rainfall ever recorded for a 24-hour period was 11.17 in. on Oct. 9, 1903. Some of the controlling factors in the design of sewers are the frequency, intensity and duration of precipitation, which result in the maximum rate of flow for each of the sewers. The intensities of rainfall for various periods noted in Table I are from an article "Rainfall Studies for New York City," by S. D. Bleich, published in the February, 1934, *Proceedings*, Am.Soc.C.E. These data are based on Weather Bureau reports for the Central Park gage of New York City for the 62 years from 1869 to 1930 inclusive.

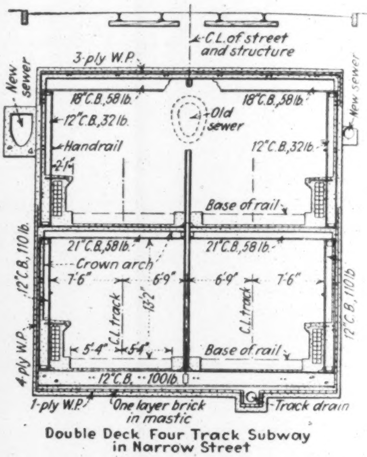


FIG. 2—TYPICAL SUBWAY SECTION, showing old sewer removed from the center of the street and replaced by two sewers outside the subway.

FIG. 3—TEMPORARY STEEL FLUME for sewer suspended from timbering of subway excavation.

TABLE I—RAINFALL FREQUENCY AND DURATION FOR NEW YORK CITY

Interval, Years	Frequency Per Year	Hourly Rainfall Rate (in Inches) Lasting for a Period of— 5 Min.	10 Min.	15 Min.	30 Min.	1 Hr.	2 Hr.
1	1	4.08	3.06	2.56	1.72	1.10	....
2	0.5	5.04	3.66	3.12	2.14	1.33	....
3	0.2	6.36	5.06	4.09	2.74	1.70	1.06
10	0.1	6.98	5.28	4.78	3.22	2.12	1.29
25	0.04	8.31	7.59	7.23	5.23	2.90	1.62
50	0.02	9.09	8.86	8.33	5.44	3.24	1.81

It is apparent from the table that the capacity of a sewer capable of taking care of a ten-year storm (for which the new sewers were designed) has to be 40 to 60 per cent larger than a sewer which only provides for a two-year storm. To provide for the maximum rainfall that may occur only once in a generation requires a stormflow capacity about double that necessary to take care of a stormflow expected to occur only once in two years. Sewers built along the Independent Subway System were designed for combined sanitary and stormflows, separate systems being used in only a few sections of the city.

Administration and mileage

All problems relating to drainage encountered in connection with subway construction are worked out in a division of the Board of Transportation's engineering department, whose personnel specializes in this work. The construction of sewers is included in the work done by the subway contractors, and it is supervised by the field engineers of the Board of Transportation in charge of the respective contract sections. Upon completion of the work, the sewers are turned over to the sewer bureaus of the respective boroughs for maintenance.

The five boroughs comprising the city of New York have been tabulated below, giving the route mileage of the Independent Subway System, the mileage of sewers rebuilt in connection with the construction of the system, the area of the city and the population according to the Health Department census of 1932.

Borough	Area, Sq.Mi.	Subway, Miles	Sewers Built, Miles	Population
Manhattan....	22	20	19	1,776,000
Brooklyn......	81	17	23	2,679,000
Bronx.........	42	7	4	1,382,000
Queens........	118	11	14	1,213,000
Richmond.....	57	0	0	168,000
Totals, New York City.	320	55	60	7,218,000

Original conditions

Sewers built in the Borough of Manhattan prior to the Civil War were of brick and generally 4 ft. circular or 4x2⅔ ft., egg-shaped. Later the minimum size used was a 3x2-ft. egg-shaped sewer. As these sewers were originally oversize and had near-by outlets at the Hudson, Harlem and East rivers, they were adequate for the subsequent intensive utilization of the land in this borough.

In the Borough of Brooklyn, 12- and 15-in. clay pipes were originally used for sewers, with larger pipes or brick construction for the trunk sewers. While suited to the conditions that existed at the time these sewers were built, they are not adequate for the maximum flow at present, as continuous rows of multiple-family houses and impervious pavements have replaced the former one-family dwellings, which were often surrounded by lawns. Relief sewers, built since 1890 to remedy this condition, complicated the problem of restoring sewers disturbed by subway construction in the Borough of Brooklyn.

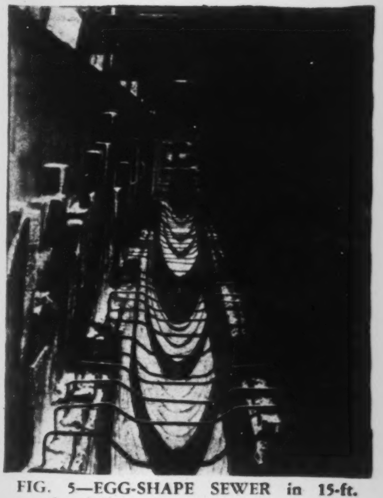


FIG. 5—EGG-SHAPE SEWER in 15-ft. trench, showing bent reinforcing rods for flat-slab top.

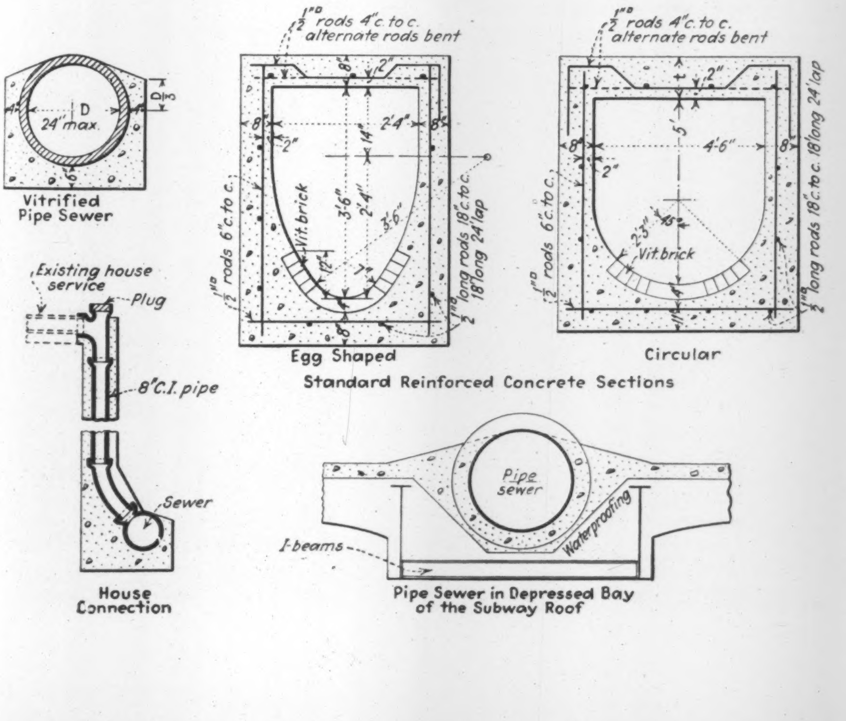
The Bronx portion of the Independent Subway System is for most of its length along the 182-ft.-wide Grand Concourse, which follows the crest of a ridge and therefore forms the summit for catchment areas. Because of its great width, this street has two lines of sewers. The subway structure along the Grand Concourse is 45 ft. wide except at stations, causing a minimum interference of the subway with existing sewers. Most of the sewer work in the Borough of the Bronx was necessitated by the reconstruction of underpasses for streets crossing the Grand Concourse.

Queens Borough has a number of sewer systems built prior to 1898, when its separate communities were combined to form a borough of Greater New York. Since that time progress has been made toward realizing complete sewering for the developed portions of this borough. Consequently, inadequate old sewers alternate with substantially constructed modern sewers along the Independent subway in Queens.

Types and materials

In reconstructing sewers along the Independent Subway System, vitrified clay pipes laid in concrete cradles were used for sewers up to 24 in. in diameter. Reinforced-concrete sewers with egg-shaped inverts and sides were used up to 4½ ft. by 2 ft. 10 in.; and for sizes up to 6½ ft. by 5 ft. 11 in. the sewers were built with semicircular inverts and vertical sides (Figs. 4 and 5). For both

FIG. 4—STANDARD-SECTION TYPES for sewers constructed in connection with Independent Subway System.



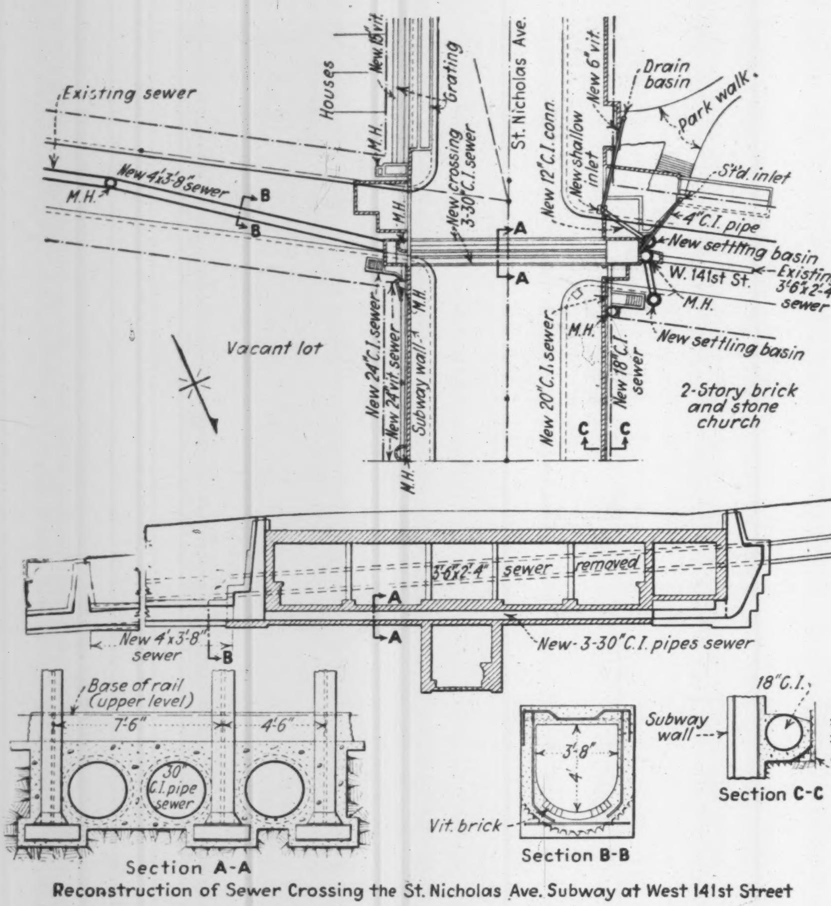

Existing sewer
Houses
New 15" vit.
Grating
St. Nicholas Ave.
New 6" vit.
Drain basin
Park walk
M.H.
New 4'x3'-8" sewer
B
New crossing 3-30" C.I. sewer
New 12" C.I. conn.
New shallow inlet
Std. inlet
4" C.I. pipe
A
New settling basin
W. 141st St.
Existing 3'6"x2'-4" sewer
Vacant lot
New 24" C.I. sewer
New 24" vit. sewer
Subway wall
New 20" C.I. sewer
New 18" C.I. sewer
2-Story brick and stone church
C
3'-6"x2'-4" sewer removed
New 4'x3'-8" sewer
New-3-30" C.I. pipes sewer
Base of rail (upper level)
7'-6"
4'-6"
30" C.I. pipe sewer
Section A-A
Vit. brick
3'-8"
4'
Section B-B
18" C.I.
Subway wall
Building
Section C-C
Reconstruction of Sewer Crossing the St. Nicholas Ave. Subway at West 141st Street

FIG. 6—SEWER CROSSING and drainage structures at intersection of St. Nicholas Ave. subway line by 141st St.

types of reinforced-concrete sewers the tops were flat slabs instead of the circular tops customary in the old brick sewers. Larger sewers have rectangular sections with curved or sloped inverts. The inverts of all concrete sewers were lined with vitrified brick. Cast-iron pipes were used for sewers located on the roof of the subway or in places inaccessible after construction. Variations from the foregoing standard sections were frequently necessary on account of the limited space available.

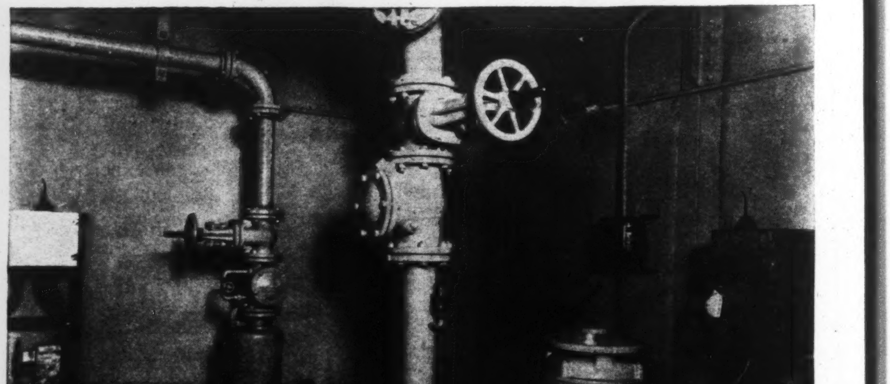
Vitrified or cast-iron pipe house connections were provided where required. In front of unimproved properties spurs for house connections were provided every 20 ft. on each side of the street; and in the case of low-level sewers, the provision for house connections included risers coming within 13 ft. of the surface. Record drawings, showing all data regarding the sewers as built and the location of spurs and risers for the house connections were made for the use of property owners and the borough sewer bureaus.

Materials used for sewer construction conform to the high standards of the specifications for subway work, and these materials are subjected to rigorous inspection from their source to the completed job. 1:2:3.85 concrete is used throughout. Tile pipe sewers are of short-length, vitrified, salt-glazed, stoneware pipe with extra deep and wide sockets and corrugated spigot ends. Mortar consisting of 1 part cement to 2 parts sand was used at all joints of tile pipe sewers. American Water Works Association Class A cast-iron pipe was used for all iron pipe sewers, heavier pipe being used for fittings and specials. Joints on cast-iron pipe sewers were calked with oakum and covered with mortar. Manholes for pipe sewers were placed at all places where there was a change in alignment or a change in the profile and at all junctions of sewers. Along straight pipe sewers, manholes were spaced 100 ft. apart, this spacing being increased for larger sewers up to a maximum spacing of 200 ft.

Special problems

The 42d St. station of the Eighth Ave. subway, a tandem-type island platform station extending from 40th to 44th Sts., with a continuous mezzanine 1,100 ft. long, was made possible by a redesign of the sewer system extending from 35th to 42d Sts. The old sewers in Eighth Ave. were removed, and those in the cross-streets were intercepted by a new longitudinal sewer along the east side of the Eighth Ave. subway. Along the west side of Eighth Ave. a new longitudinal sewer was built for local service, and both discharge into a trunk sewer in 39th St., flowing west to the Hudson River. At the Eighth Ave. subway crossing the 5x4-in. trunk sewer in 39th St. was changed to three 42-in. cast-iron pipes, and the grade of the sewer invert was dropped 8 ft. in order to pass these pipes between the two levels of the double-deck subway structure at this location. The construction of 2,800 ft. of $6\frac{3}{4}$x$7\frac{3}{4}$-ft. sewer in 39th

FIG. 7—AUTOMATIC duplicate pump station at subway sump for track drainage.



St., west of Eighth Ave. on a grade of 1/10 of 1 per cent, made it possible ultimately to rejoin the old trunk sewer at the hydraulic grade, so that it was unnecessary to build a new outlet at the Hudson River.

In 1918, due to the construction of the Seventh Ave. subway, a 9¼-ft. circular sewer was built in 30th St. as an off-line sewer crossing Eighth Ave. and extending west to the Hudson River. To provide space for the construction of the Eighth Ave. subway of the Independent System, the masonry sewer was manifolded into three 76-in., cement-lined, riveted-steel pipes at the Eighth Ave. crossing. This change provided 3 ft. of additional depth for the new subway and for the utilities above it.

At St. Nicholas Ave. the original sewer in 141st St. was on a steep grade parallel to the street surface. The track profile as well as economy in cost required that the St. Nicholas Ave. subway be built as close to the street surface as possible, so that the sewer would have cut through the upper portion of the double-deck subway planned in St. Nicholas Ave. An interesting and inexpensive design for reconstructing the sewer crossing the subway was developed (Fig. 6). A drop manhole and transformer were introduced, to lower the upstream elevation of the sewer 13 ft. for crossing the subway. The lower part of the subway structure was depressed locally a sufficient distance to permit three 30-in. cast-iron pipes to be placed between the track floor beams forming the roof over the low-level track. Only 130 ft. of 4x3⅔-ft. sewer was required to rejoin the grade of the old sewer on the downstream side of the subway crossing.

East of the Utica Ave. express station on the Fulton St. subway of the Borough of Brooklyn, longitudinal sewers and those in the side streets were at the customary depth of 10 to 12 ft. below the street surface. The subway structure occupies practically the entire 80-ft. width of Fulton St. Two different and originally unrelated street layouts terminate along each side of Fulton St., and none of these streets match up for a direct crossing at Fulton St. These conditions made it necessary to reconstruct the sewers at their original location in the center of the street, and required that the subway be built at an unusual depth. At two side-platform local stations along this portion of the subway, sewers were so planned that advantage could be taken of this condition to provide mezzanine entrances to the stations. These mezzanines compensate in part for the heavy first cost of the subway structure by reducing the number of agent-operated controls required, and they also provide more convenient access for passengers to the station platforms.

Along the Grand Concourse in the Borough of the Bronx, six highway underpasses were lowered from 16 to 25 ft. on account of the subway construction. At the 167th St. underpass, which was lowered 25 ft., the capitalized value of a sump with the drain in a shallow trench exceeded by $30,000 the cost of building a 900-ft.-long, deep, level gravity drain. Gravity drainage was used at all the highway undercrossings reconstructed along the Concourse, as the cost of excavating for a deep level drain was in each case less than the cost of a sump and pump with the drain in a shallow trench, plus the capitalized value of operating expenses, plus amortization of equipment.

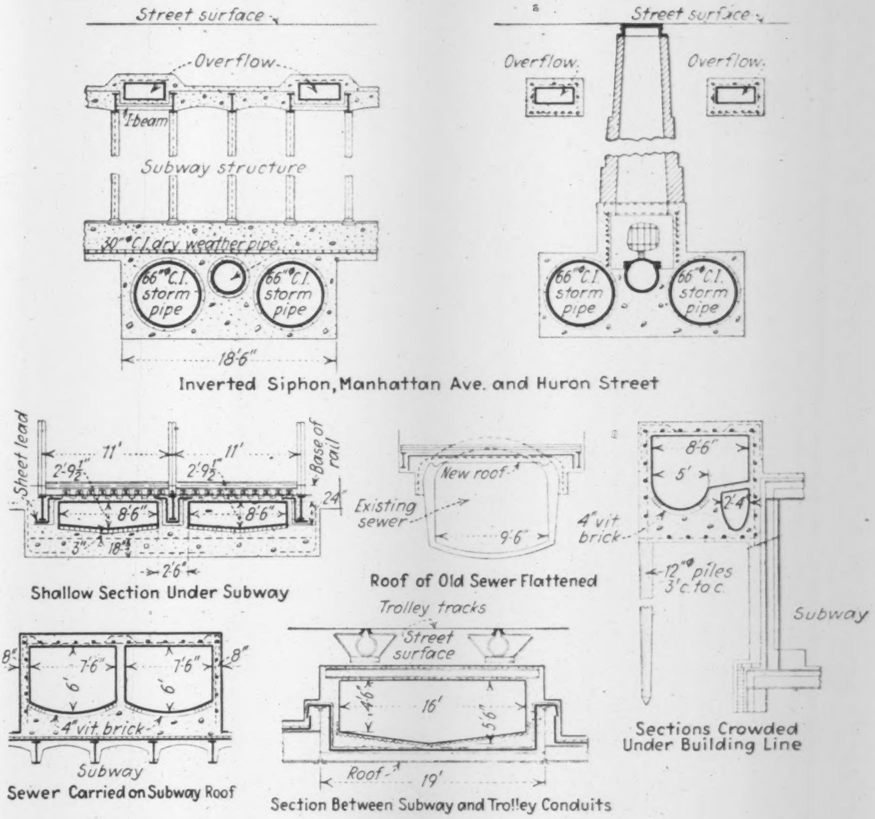

Street surface
Overflow
I-beam
Subway structure
30" C.I. dry weather pipe
66" C.I. storm pipe
66" C.I. storm pipe
18'6"
Street surface
Overflow
Overflow
66" C.I. storm pipe
66" C.I. storm pipe
Inverted Siphon, Manhattan Ave. and Huron Street
Sheet lead
11'
11'
2'9½"
2'9½"
Base of rail
24"
8'6"
8'6"
3"
18"
2'6"
Shallow Section Under Subway
New roof
Existing sewer
9'6"
Roof of Old Sewer Flattened
8'6"
5'
2'4"
4" vit brick
12" piles 3' c. to c.
Subway
Trolley tracks
Street surface
8"
7'6"
7'6"
8"
6'
6'
4" vit. brick
Subway
Sewer Carried on Subway Roof
4'6"
16'
5'6"
Roof
19'
Section Between Subway and Trolley Conduits
Sections Crowded Under Building Line

FIG. 8—TYPICAL INVERTED SIPHON and special sections adopted where clearance room was restricted.

Inverted siphons

In designing the five inverted siphons constructed in connection with the relocation of sewers along the Independent Subway System, many improvements were incorporated that were the result of operating experience with 21 inverted siphons previously built in New York City's subway program. Table II gives the make-up of these siphons.

One sanitary pipe and two or more pipes for stormwater flow are used at each siphon, with an overflow across the roof of the subway, of such size as other subsurface structures permit (Fig. 8). The sanitary flow is directed to its siphon pipe by dams at the inlet chamber, with similar dams at the outlet to prevent this flow from backing into the stormwater pipes. A valved bypass is installed for temporarily diverting the sanitary flow into one of the stormwater pipes when the sanitary siphon is being cleaned. Loss of head is reduced by sloping the pipes connecting from the sewer to the siphon level. Chambers at the sewer-siphon junction and cleanout manholes are so designed that ample space is available for inspections and maintenance.

Track drains and underground streams

Seepage or surface water finding its way into the subway is drained along

TABLE II—INVERTED SIPHONS BUILT ALONG THE INDEPENDENT SUBWAY SYSTEM

Location	No. and Size of Pipes. Storm	No. and Size of Pipes. Dry Weather	No. and Size, Overflow	Length, Ft.	Dip, Ft.
124th St. & St. Nicholas Ave.	3 of 48"	1 of 24"	1 of 5'x4' 9"	185	15.7
Norman & Manhattan Ave.	2 of 60"	1 of 24"	2 of 2' 4"x4'	169	13.3
Huron & Manhattan Ave.	2 of 66"	1 of 30"	2 of 1' 6"x3' 6"	110	13.5
40th Ave. & North Blvd.	2 of 72"	1 of 42"	2 of 2' 3"x4' 3"	170	15.5
61st St. & Broadway	2 of 60"	1 of 30"	2 of 1' 9"x4'	142	14.0

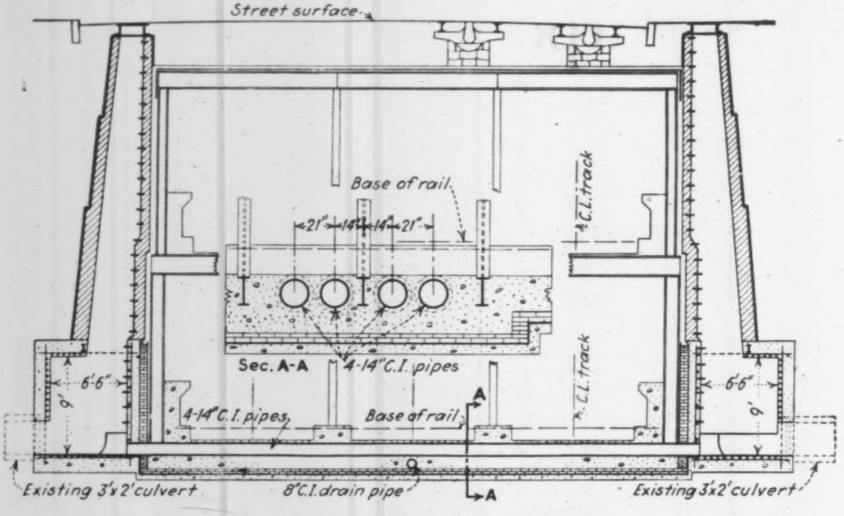


FIG. 9—CULVERT CROSSING of subway at Central Park West and 75th St.

the track trough or through pipes to sumps located at low points of the subway. The average capaciy of a sump below its inlet is 5,000 gal. The usual equipment of a pump room (Fig. 7) for a sump consists of two automatically operated motor-driven pumps, one of 100-gal. per minute capacity for normal operation and a 500-gal. per minute pump for emergencies.

The subway structure crosses a number of old water courses. Although buildings and pavements have dried their original sources, water still flows in these old stream beds, which must be disposed of to prevent the building up of hydrostatic pressure on the subway and also to prevent damage to other subsurface structures. Sometimes these old streams are connected to the track drains, and they are thus drained to a sump from which the water is pumped to the city sewers. In most cases inverted siphon culverts are provided to take the flow of such streams under and across the subway structures. These culverts (Fig. 9) are designed similar to the inverted sewer siphons, with underground inlets and outlets, and with manholes for inspection and maintenance.

Provision for future work

The sewer bureau of the Borough of Manhattan has planned a new drainage system to be built for a portion of the borough located south of 14h St. Sewers in this area, rebuilt in connection with subway construction, were therefore designed to function properly for the present flow, and at the same time they were so located and made of such size as to meet the requirements of the new drainage system. In the partly developed portions of Queens Borough, sewers were built in connection with subway construction so as to fit in with the plans of the sewer bureau for future sewers. This will save the expense of destroying the pavements and of re-excavation at the subway when the future sewers are constructed. The cost of the sewers over that of the normal replacement of existing facilities was paid for out of the borough funds.

The problems enumerated describe only a few of the situations that arise in planning the relocation of sewers on account of subway construction. They illustrate the extent to which subways multiply the difficulties of the engineer in designing adequate substitutes for existing sewer facilities at the lowest cost consistent with sound engineering practice.

The foregoing work was designed and constructed as part of the city-owned Independent Rapid-Transit System of New York, under the supervision of the Board of Transportation, of which John H. Delaney is chairman, and Robert Ridgway was (until his recent retirement) chief engineer. Jesse B. Snow has succeeded him in that position.

The plans for the Independent Subway System were prepared under the direction of A. L. Raisman, chief designing engineer, Messrs. Conover, Myers and Shipman were division engineers on this work. S. D. Bleich is assistant division engineer in charge of sewers, and Alfred Brahdy is designing engineer for the Board of Transportation.

◆

Regulation of Population Density Proposed for Manhattan Island

CITING the high population density permitted by the Knickerbocker Village low-cost housing project in New York (750 persons per acre on gross area), the Regional Plan Association in a recent bulletin, presenting a study of existing population density on Manhattan Island, warns that new housing projects calling for as great a density as 300 persons per gross acre must be limited in area and must be balanced by use of other areas of densities of less than 300 persons per gross acre. Otherwise blighted areas will become more blighted and be greater in extent.

A little more than half the total area of Manhattan is now used predominantly for residence. If this portion were built up solidly with the density of the new Knickerbocker Village project, it could house about 3½ times the number now living thereon and 87 per cent of the total 1930 population of the entire city. As Manhattan has been steadily losing population since 1910, there is obviously no necessity from the point of view of availability of land for such a density.

Based on the premise that the proportion of land area on Manhattan Island devoted predominately to residences will remain about the same as now, it is concluded that the future average density of population cannot exceed the average in present areas unless a considerable portion of those areas is converted into public open spaces.

The study disclosed that while the densest block in Manhattan in 1930 had 635 persons per gross acre and the densest sanitary district had 450 persons per gross acre, the average on all residential areas was only 189 persons per gross acre. In order to enforce density standards for different zones and keep the average within expected limits (that is, about 210 persons per gross acre south of the George Washington Bridge), the present zoning ordinance and multiple-dwelling law would have to be revised.

The two densest blocks, which are in or near the lower East Side, have a population density of 635 and 630, respectively, per gross acre. The five densest census tracts in Manhattan have population densities varying from 400 to 450 persons per gross acre. Brooklyn's densest census tract has 320 persons per gross acre. Comparable figures for large housing projects existing or under construction are Knickerbocker Village, 750; Amalgamated Dwellings, Inc. (Grand St.), 390; Hillside Housing Corp. (Bronx), 260; Boulevard Gardens Housing Corp. (Queens), 220.

The report states that there are several possible methods of regulating density, and that one of these or a combination of them should be developed by the city authorities, preferably through the agency of an official city planning board.

Ithaca Improves Its Airport With Relief Labor

Clearing of 95 acres of trees and bush, grading, runway and hangar construction, drainage and water-supply installations and the addition of 15 acres of hydraulic fill converted a poor field into a model small-town airport

By H. W. Eustance
City Engineer, Ithaca, N. Y.

MANY CITIES seized the opportunity of using FERA funds in opening new airports and developing existing ones. Among these was Ithaca, N. Y., which through an expenditure of $103,000 (of which the FERA contributed $61,000 and the city $42,000) improved an existing field into a model small-city layout. Employment was provided for 100 men for a period of ten months. Of the total cost, $51,000 went to labor, and $52,000 was spent for materials and equipment. The airport work supplemented the large swamp-reclaiming program, also done by relief forces, described in *ENR*, May 24, 1934, p. 655.

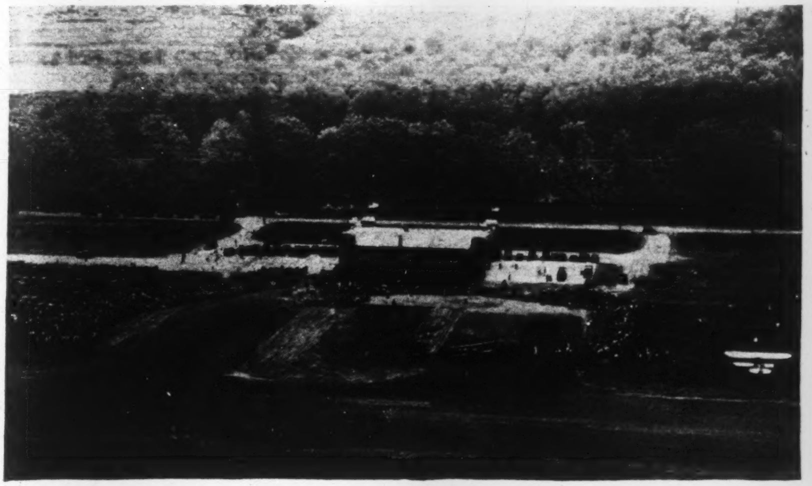


FIG. 1—DEDICATION DAY at the Ithaca Airport, which was built by relief workers.

Ithaca's airport, although municipally owned, was first opened in 1914 as a home field for one of the earliest airplane manufacturers. Under its operation turf runways were opened through the woods on the site, and a frame hangar was constructed. The field possesses enviable natural advantages. It is at the head of Cayuga Lake, one of the well-known Finger Lakes, and easily located from the air. Sheltered by a hill on the west, it enjoys the advantage of being a one-way field. Most winds are deflected either north or south, the long direction of the field. So seldom does a cross-wind handicap landing in a north or south direction that only one runway is necessary. Ithaca and the field are practically fog-free. The field is nearly dead level, no part of its 120 acres being more than 3 ft. higher or lower than another.

In spite of these natural advantages, the field left much to be desired. The hangar was old and inflammable and too small for storing visiting planes. Only 25 out of the 120 acres were cleared, graded and available for landings (Fig. 2). These landing areas were bounded by the hazards of trees and ungraded portions of the field. There were no paved runways, and in soft weather takeoffs were difficult. The field was unlighted. There was no water supply.

Work on the airport embraced six major items: (1) clearing, grading and seeding, (2) runway construction, (3) hangar construction, (4) installation for drainage system, (5) provision for water supply, and (6) hydraulic-fill work.

Clearing, grading and seeding

Of the 120 acres, 95 had to be cleared of varying growths of trees and bush. An area of about 30 acres was covered with a thick but young growth of poplars and willows, ranging from whip size to 2-in. poles. The smaller of these were removed by parties of two—one man with a long-bladed spade assisted by the pulling strength of his partner. The larger growth that could not be spaded was pulled successfully by four laborers using a lever of wagon-tongue length on a pair of wagon wheels. A light chain was wrapped around the trunk, and a pull of the lever would uproot a fair-sized sapling. The soil was sandy. On a 50-acre area there was a thick growth of soft woods, mostly willows, with trunks up to 30-in. diameter. Few of these pulled easily without being dug because a double set of roots had formed—the original ones and a new set located just beneath the top of a 20-year-old, 2-ft.-deep, hydraulic fill.

All stove wood was given to city welfare clients for fuel. Stumps and brush were piled and burned with the aid of all the old crankcase oil that could be collected around the city.

The land, when cleared, needed much working, to get good surface drainage and the smooth surface demanded by an airport. Half of the heavy wooded section had originally been a peach orchard, and the farmer, in a reported vain attempt to get the fruit-tree roots above groundwater, had graded the land into a series of 3-ft.-high ridges. These furrows were graded out by plowing deep with a breaking plow, the loosened dirt being pushed sideways with a road grader. Stump holes were filled by trucking in dirt. The entire area was finish-graded by disk-harrowing and leveling with a road grader; after six months' settlement the process was repeated. Fifteen acres of the field along the lakefront was swampy land covered with a growth of large willows. A hydraulic dredge was deepening Cayuga Inlet channel, a part of the New York State Barge Canal, and spoil from this work was discharged in this area. Dikes, to hold the fill, were constructed with relief labor. In all clearing and grading operations, equipment was used extensively to supplement hand-labor work.

It has been decided not to seed the area east of the runway. A luxuriant growth of quack grass has been fostered by the continual working, and this is expected to develop into a satisfactory sod. Areas west of the runway, adjoining the highway, were carefully fine-graded and seeded, 100 lb. to an acre, with a grass of the following formula: Kentucky bluegrass, 60 per cent; Canada blue, 20 per cent; red top, 15 per cent; South German bent, 5 per cent.

Runway

The major feature of the new field is the paved runway, 2,500 ft. long and 100 ft. wide, with a 250-ft. diameter turn-around on the south end. Approach runways were also built from each door of the hangar, and concrete aprons and entrance roadways were built. Some 38,000 sq.yd. were graded and surfaced.

The runways were brought to a perfect grade, taking advantage of what little surface slope the field possessed. Where dirt had to be moved long dis-

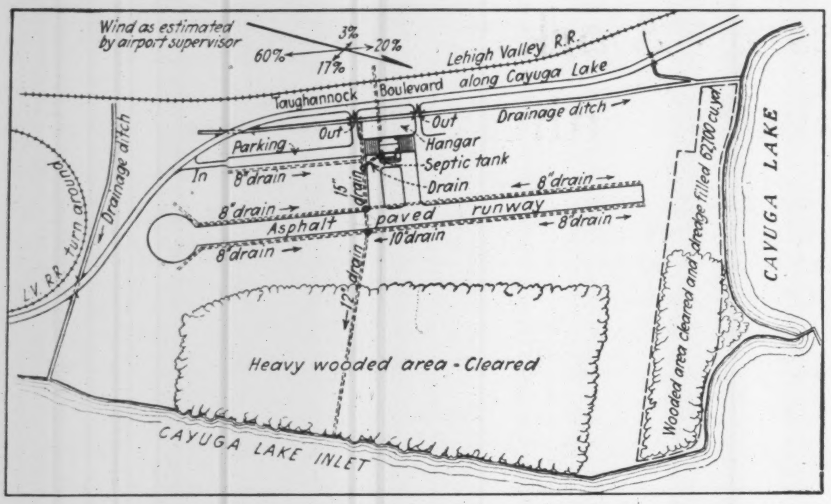


FIG. 2—LAYOUT OF ITHACA AIRPORT in the development of which relief workers cleared nearly 100 acres of wooded land and built all the necessary structures.

tances, it was loaded on trucks and wagons by hand; where a short move was possible a bulldozer and motor grader did the work. The subgrade was rolled with a 10-ton roller. The base of the runway was of shale rock and dirt, deposited in two layers averaging 5 in. each when compacted by a heavy bulldozer and the 10-ton roller. Continuous rolling broke the shale up into about 1-in. particles, which permitted grading with the road machine. After grading, a 9-in. crown was obtained, the stone being filled with the sandy soil from along the edges of the runway. This soil burden was broomed in and rolled. The surface was then treated with asphaltic road oil, 0.4 gal. per sq.yd. On this, an asphaltic cutback surface treatment was spread in two applications of 0.4 gal. and 0.3 gal. per yard., covering the first coat with 35 lb. of crushed stone, under $\frac{3}{4}$ in., and the second coat with 20 lb of stone under $\frac{1}{2}$ in. The surface was broomed and rolled and has the appearance of a sheet-asphalt pavement. It has proved remarkably tough under the hard usage of 30 student pilots, practicing landings.

Hangar

The second major feature of the work was the construction of a cinder-block hangar 80x100 ft. in plan, with an attached administration wing 25x60 ft. Effort was made to secure an architecturally attractive building. The cinder block was carefully laid and jointed, eliminating the necessity for a stucco coat. Such care greatly increased the labor of masons on the work, but as a relief project it was felt justified. The finished appearance resembles cut stonework. The roofing is corrugated asbestos supported without roof boards on bar-joist purlins spaced 4 ft. on centers. Steel roof trusses are supported by steel columns. Doors with a 60x17-ft. opening were installed on both ends of the hangar. The administration wing is separated from the main hangar by fire doors, and is partitioned off into a large shop, waiting room, office and pilot's room, two toilets and a boiler room. The inside of these rooms is plaster-finished. Only the wing is heated.

The roof of the wing is designed for and used as an observation platform overlooking the field. The area around the hangar was landscaped, concrete sidewalks were built and grass plots enclosed and protected by laying a low curb, utilizing old paving block.

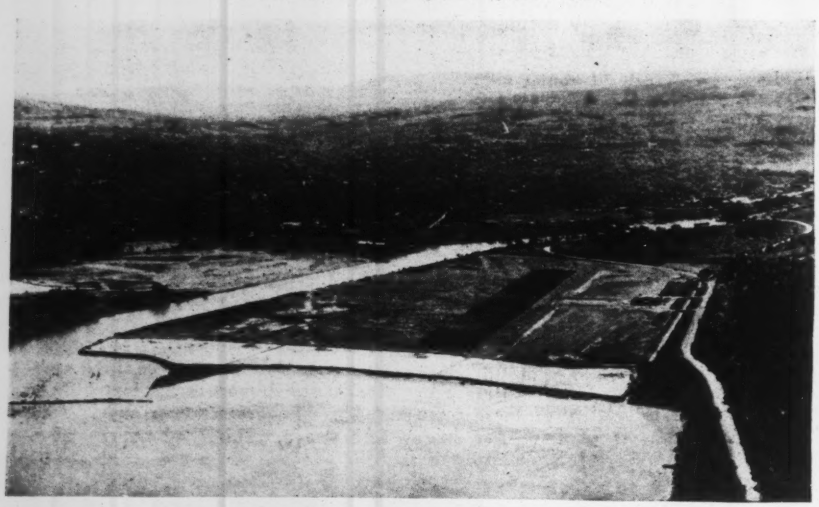


FIG. 3—FINISHED FIELD from the air. Extension into lake in foreground was made by hydraulic dredges. Across the inlet is part of the city park and golf course, also reclaimed from swamp land by relief labor.

Water supply and drainage

A water supply was brought to the hangar by cutting cross-country on private right-of-way from the nearest city main some 1,100 ft. away.

Because of the flat nature of the field it was impossible to grade for perfect surface drainage. This and the fact that with high lake levels the groundwater is close to the surface made considerable subsurface drainage advisable. Water collecting from the hill to the west is led to the lake by a large canal-like open ditch. The ditch must be kept at a large cross-section, to keep the run-off from piling up in wet weather and flooding the field. No slope is possible in this drainage canal. Its surface is lake level.

The main subsurface drainage consists of 8-in. vitrified sewer tile lines laid parallel to the runway on each side, 4 ft. away from the edge of the surface. The trenches are about 30 in. deep, narrow and backfilled to within 7 in. of the surface with the shale rock. The drainage system utilizes two outlets, to give all the runoff possible during periods of high lake level and high groundwater. They are connected to drain to the drainage canal, the lake or the inlet. Where drains cross the runway, 12-in. corrugated metal pipe is used. Flat portions of the field were likewise drained with pipe running from the main system.

The project was planned by the writer. J. V. Larkin, architect, designed the hangar. Construction personnel was engaged and directed by the local work bureau.

◆

Leveling Net to Be Finished By Early Summer

The job of accurate leveling along lines spaced about 25 miles apart over the 3,000,000 sq.mi. of the United States will be practically finished by July 1, according to Capt. R. S. Patton, director, U. S. Coast and Geodetic Survey. In January 12,353 miles of accurate leveling were added to the national net, and during February 10,228 miles were added.

This great expansion in the leveling operations of the Survey, involving more than 215,000 miles of lines, has been made possible by PWA funds.

Bridge and Paving Work in Detroit Street-Widening

Ninety-foot pavement on Woodward Ave., Detroit, Mich., illustrates latest practice trends in constructing sheet asphalt on concrete base

THE WIDENING of Woodward Ave., in Detroit, Mich., which was inaugurated a few years ago with land acquisitions for a $10,000,000 right-of-way, has gone ahead during the last two years with the construction of a large overhead dual crossing for five railway tracks and the laying of 0.68 mile of 90-ft. paved roadway and two 15-ft. sidewalks on a normal 120-ft. right-of-way. Continuation of the widened pavement south about ¾ mile is planned, which will give a 120-ft. street to Grand Circus Park and improvement about half a mile farther to a focal point with Gratiot and Michigan Aves. at Campus Martius and the Detroit City Hall. Northward at the city line the widened avenue continues into the dual 44-ft. roadways to Pontiac and their four-lane extensions to Flint, Saginaw and Bay City. Together the Bay City-Detroit road and the widened Woodward Ave. will form one of the most magnificent state trunk-road entrances to an American city.

The dual highway from the Detroit city line to Pontiac was described in *Engineering News-Record*, March 4, 1926, and a later issue of April 29, 1926, described the notable hydraulic-fill grading operation between Bay City and Saginaw. The recent overhead crossing construction and the wide paving operation of 1934 on Woodward Ave. are described here. As a convenience in orienting the improvement and its several parts the sketch map, Fig. 2, is given.

Overhead crossing

As shown by Fig. 2, the tracks of two railways cross the avenue about 3 miles from the City Hall end. The old street, 50 ft. wide between curbs and 90 ft. wide between property lines, was spanned by 54-ft. plate girders and short-beam end spans over the sidewalks. One bridge carried the two tracks of the Grand Trunk Western Railroad, and the other carried the three tracks of the Michigan Central and New York Central railways. The two bridges were parallel but separated by about 50 ft. For the widened street a longer span and heavier structure were called for and also a structure which conformed architecturally to the importance of the street improvement.

The general design as developed is shown in Figs. 1 and 3. As affecting vehicular traffic, the two crossings formed a single underpass. The requirements for railroad purposes were identical except in the number of tracks accommodated. Architecturally and structurally, design as a dual structure seemed indicated. As shown by the illustrations, portal abutments span the sidewalks with columns on the curb line and solid rear walls on the property line. The design is identical on each side of the crossing for the two bridges except that one abutment has three bays (M.C.R.R.) and the other has two bays (G.T.W.R.R.) Visual continuity of abutment structure is expressed by curtain walls connecting the abutments on each side across the space which separates them and by ornamental iron fences on the parapet of the curtain wall and on the curb line between columns.

General design characteristics of the abutments are indicated by Fig. 3. The design, it will be noted, allows easy widening of the Michigan Central abutments when that railway decides to occupy more of its right-of-way width. Similarly the crossing design (two girders for each track) can be duplicated up to three additional tracks. The crossing for each track consists of two plate girders 96½ ft. long end to end and 95½ ft. between pin bearings. The floor consists of I-beams spaced 3 ft. apart, carrying a massive trough deck of reinforced concrete. A design detail that was featured more than usual was the drainage of the fill carried by the abutment superstructure. The system of pipe drains is shown by Fig. 3.

Construction of the overpass was largely a problem of maintaining railway traffic. The plan adopted was: (1) to concentrate train movements at the crossing to three tracks; (2) to place these tracks on a temporary bridge located between the two original bridges; (3) to build the temporary structure of the span girders of the old bridges; and (4) to build timber trestle approaches to the temporary bridge. Fig. 4 shows the track changes and temporary structures. The location of the temporary new crossing between the two old crossings cleared the site for the new crossing structures, which were then

FIG. 2—WOODWARD AVE., Detroit, Mich., showing completed and proposed widening.

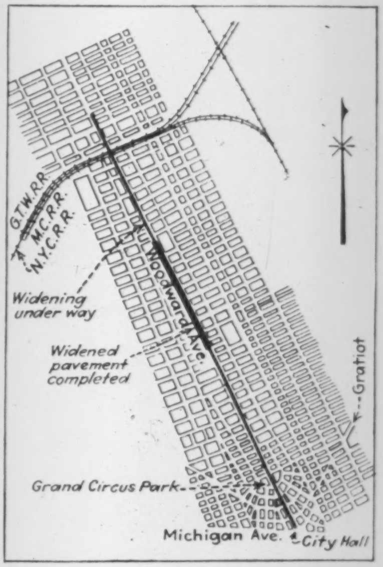
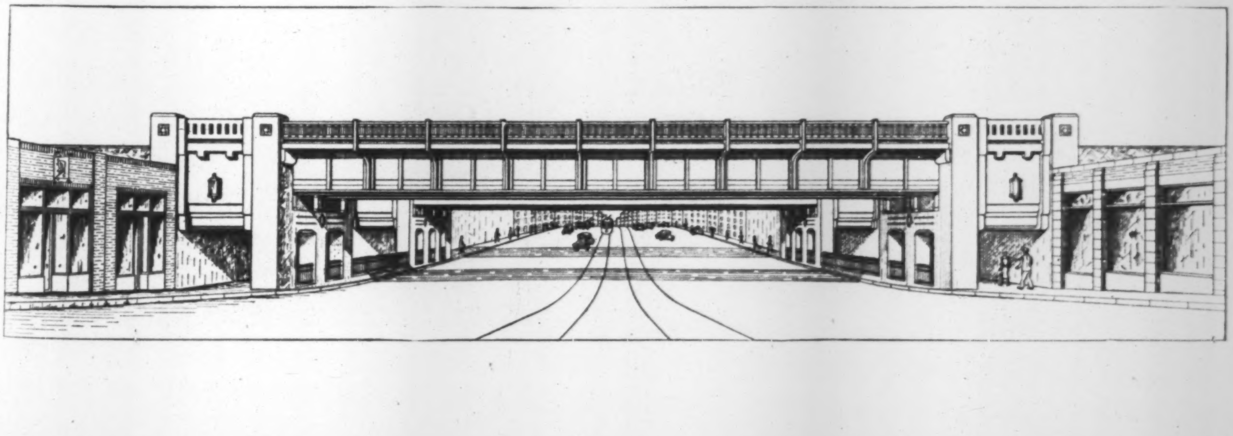


FIG. 1—DUAL overhead crossing structure carries Grand Truck and Michigan Central railways over widened Woodward Ave. in Detroit, Mich.



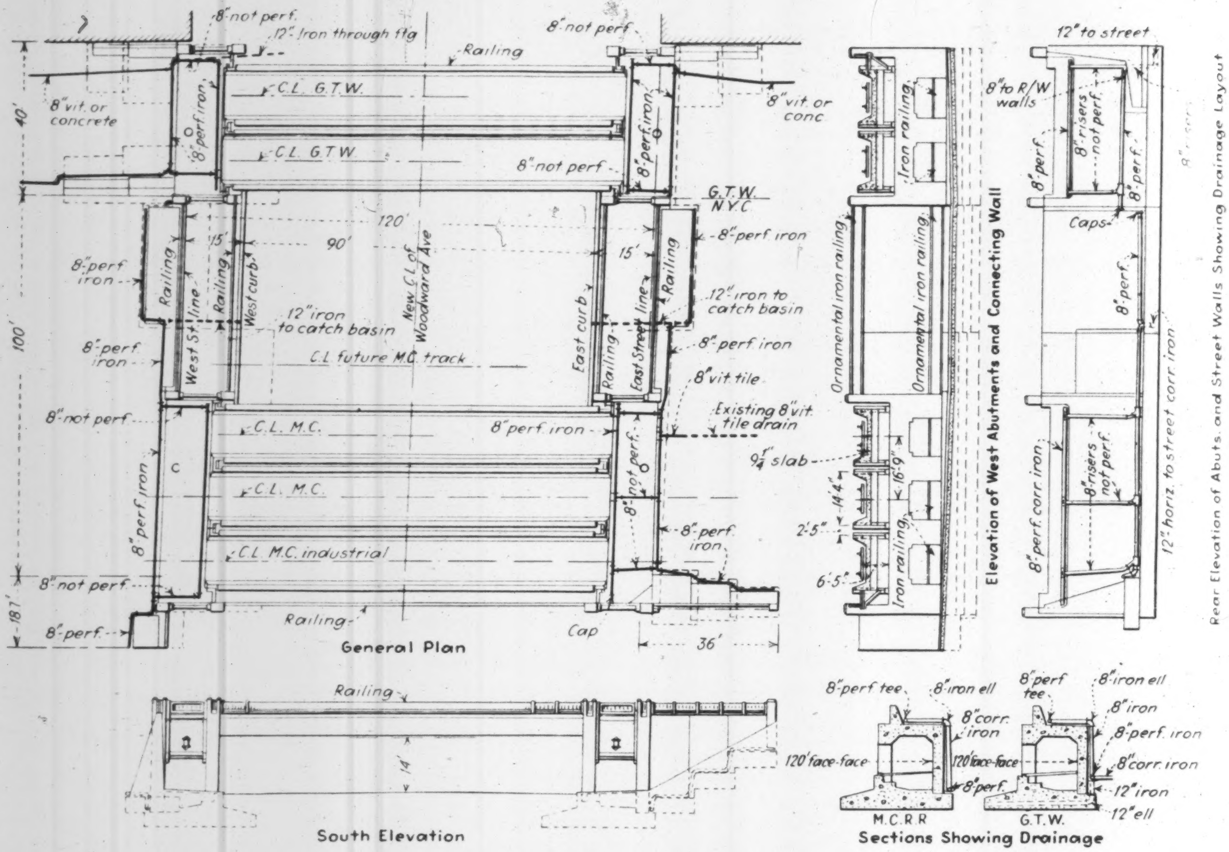

8" not perf.
12" iron through ftg
Railing
8" not perf.
8" vit. or concrete
8" perf. iron
C.L. G.T.W.
C.L. G.T.W.
8" vit. or conc
8" not perf.
8" perf. iron
G.T.W.
N.Y.C.
40'
120'
90'
15'
15'
8" perf. iron
8" perf iron
Railing
West St. line
Railing
West curb
New C.L. of Woodward Ave
East curb
Railing
East Street line
Railing
12" iron to catch basin
12" iron to catch basin
100'
8" perf. iron
C.L. future M.C. track
8" perf. iron
8" vit. tile
8" not perf.
Existing 8" vit. tile drain
C.L. M.C.
8" perf. iron
C.L. M.C.
8" not perf.
8" perf. iron
C.L. M.C. industrial
8" perf. iron
8" not perf.
18'
8" perf.
Railing
Cap
36'
General Plan
Railing
14'
South Elevation
Ornamental iron railing
Iron railing
Ornamental iron railing
9¼" slab
16'9"
14'4"
2'5"
6'5"
Iron railing
Elevation of West Abutments and Connecting Wall
12" to street
8" to R/W walls
8" perf.
8" risers not perf.
8" perf.
Caps
8" perf.
8" perf. corr. iron
8" risers not perf.
12" horiz. to street corr. iron
Rear Elevation of Abuts. and Street Walls Showing Drainage Layout
8" perf tee
8" iron ell
8" corr. iron
120' face-face
8" perf.
M.C.R.R.
8" perf tee
8" iron ell
8" iron
8" perf. iron
120' face-face
8" corr. iron
12" iron
12" ell
G.T.W.
Sections Showing Drainage

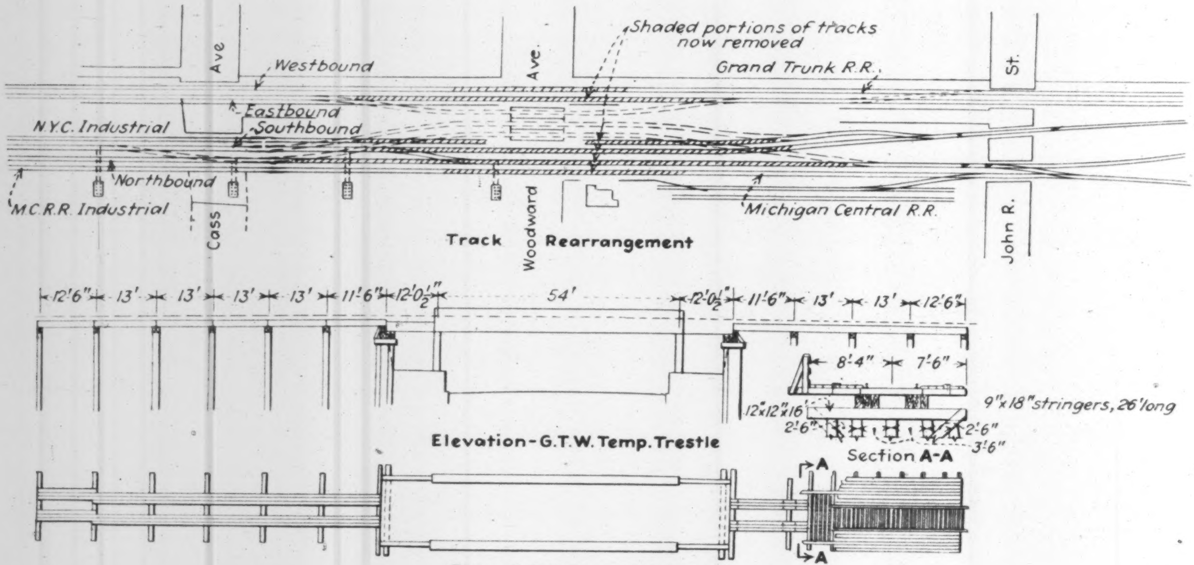
FIG. 3—GENERAL structure plan for overhead railway crossing of widened Woodward Ave., showing drainage system.

built by ordinary methods of concreting and steel erection.

Street design

As previously stated, the general plan for street improvement was to widen the street between property lines from 90 to 120 ft. and to widen the pavement from 50 to 90 ft. The design problem was thus virtually to produce a new street structure. Besides pavement, curbs and sidewalks, the design included subsurface structures and a track structure for a double-track street railway. A new axial alignment of the street was also required by right-of-way restrictions. The axial line of the old street was a tangent; to preserve this straight alignment, widening an equal amount on both sides would be required. In the practical task of securing right-of-way, sensible economics dictated that it be secured on the side of the street where it could be had more cheaply and would in-

FIG. 4—TEMPORARY CROSSING for railways during construction of permanent dual overhead crossing of Woodward Ave.


Shaded portions of tracks now removed
Ave
Westbound
Ave.
Grand Trunk R.R.
St.
Eastbound
N.Y.C. Industrial
Southbound
Northbound
M.C.R.R. Industrial
Cass
Woodward
Michigan Central R.R.
John R.
Track Rearrangement
12'6"
13'
13'
13'
13'
11'6"
12'0½"
54'
12'0½"
11'6"
13'
13'
12'6"
8'4"
7'6"
12"x12"x16'
9"x18" stringers, 26' long
2'6"
2'6"
3'6"
Section A-A
Elevation-G.T.W. Temp. Trestle
A
A
Plan - G.T.W. Temp. Trestle

volve a smaller number of changes in street-side structures, and these conditions changed from side to side of the street. The axial line of the street was changed from a straight line to long curves and tangents fitting more closely with a practicable right-of-way.

In general, the pavement design was standard as shown by the drawings of Fig. 6. A sheet-asphalt surface on concrete base was adopted in accordance with the more common street practice in Detroit; this surfacing followed standard city and state specifications, design interest centering in the concrete base. This, as an example of recent attention to quality and refinement of slab structure, merits particular attention.

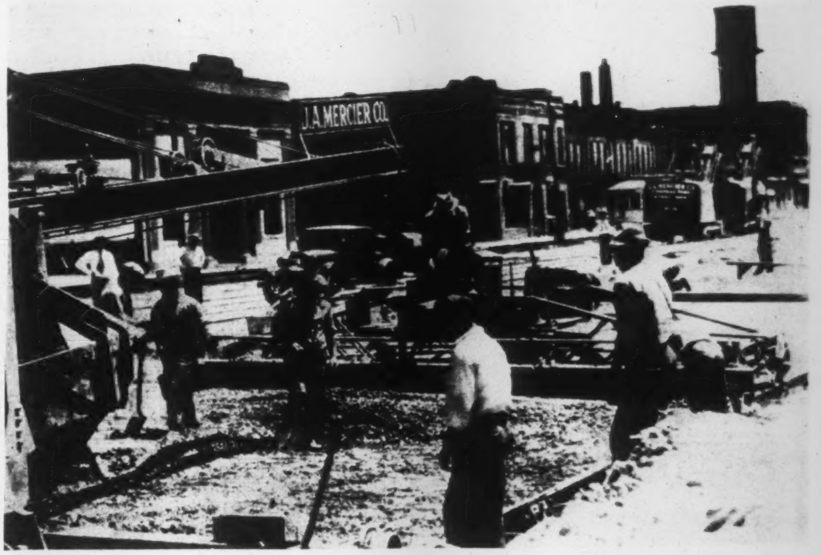

J.A. MERCIER CO.

FIG. 5—CONCRETE BASE CONSTRUCTION with finishing machine for sheet-asphalt pavement on Woodward Ave.

Concrete base design

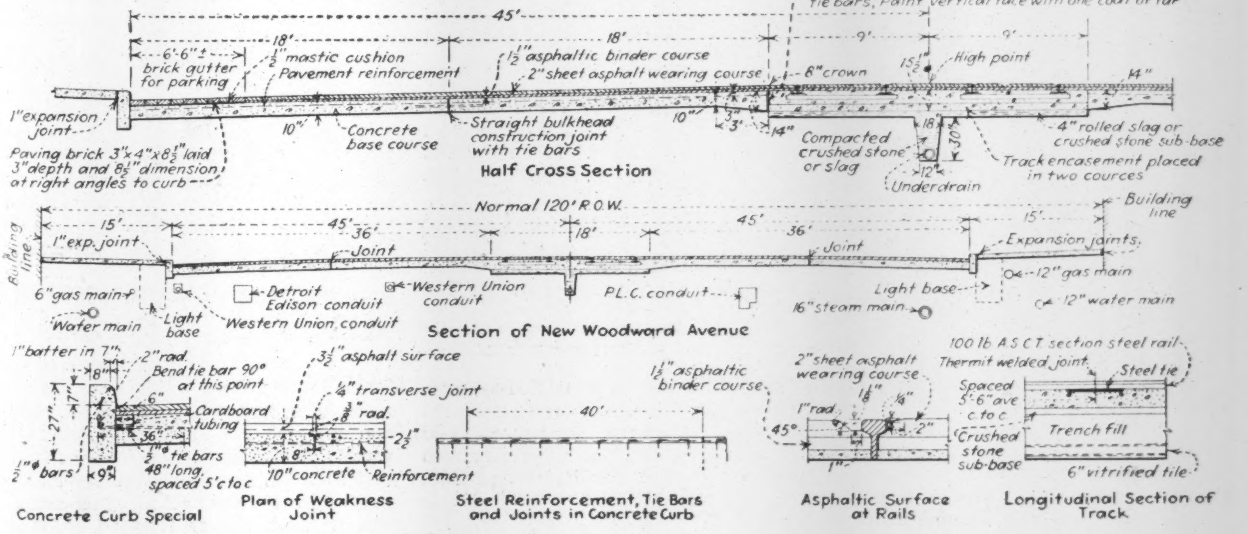
Movement due to temperature and moisture action on the concrete is provided for by dividing the base by joints into slabs of moderate area separable by the induced forces. As shown, six longitudinal joints and transverse planes of weakness at the spring of street returns and at every 40 ft. between, divide the base, except under street-railway tracks, into slabs of a maxium of 18x40 ft. At every transverse plane of weakness (dummy joint) there is an expansion joint through the curb. At curbs the longitudinal joints are expansion joints with step dowels, at the track zone they are plain construction joints without dowels, and at the middle of the 36-ft. side slabs they are construction joints with fixed dowels.

The normal base slab is 10 in. thick except at junctions with the track encasement, where it has standard-type thickened edges 14 in. deep. This design detail meets the local condition of concentrated streetcar load and also is a construction convenience. The base concrete (except in the streetcar track encasement) is about a 1:2½:4 mixture having a 28-day crushing strength of 2,000 lb. and a modulus of rupture of 500-600 lb. At 3 in. below the top, except in the streetcar track encasement, which is unreinforced, the slab has a welded wire-mesh reinforcement of about 6 lb. a square yard. In the streetcar track zone the base has a thickened center and, for precision and ease of track installation, was designed in two layers. The encasement concrete is about a 1:2:3½ mixture, with a 28-day crushing strength of 2,500 lb. and a rupture modulus of 500-750 lb.

Asphalt surface design

Surfacing design called for the usual two layers—binder (1½ in.) and wearing course (2 in.) For the binder the mixture consisted (by weight) of 76 per cent limestone (1½ to ¼ in.), 19.2 per cent pit sand and 4.8 per cent asphaltic cement (Mexican asphalt, average 56 penetration). Two mixtures were used on the top, one employing limestone dust as filler and the other silica dust. In both mixtures the asphaltic cement was a blend of equal parts of Mexican oil asphalt and Trinidad native lake asphalt, which gave a bitumen content of 85 to 86 per cent and an average penetration of 50. The average sand grading showed 35 per cent passing an 80-mesh and retained on a 200-mesh screen. Both mixtures were designed to obtain 2,000-lb. stability (Hubbard-Field) with 2 to 4 per cent voids in the compressed mixture; tests showed the mixtures to vary

FIG. 6—STREET AND PAVEMENT structures for widened Woodward Ave.


Straight bulkhead construction joint without tie bars, Paint vertical face with one coat of tar
45'
18'
18'
9'
9'
6'-6"±
brick gutter for parking
½" mastic cushion
Pavement reinforcement
1½" asphaltic binder course
2" sheet asphalt wearing course
8" crown
15½"
High point
14"
1" expansion joint
10"
Concrete base course
Straight bulkhead construction joint with tie bars
10"
3"
3'
14"
18"
30"
12"
Compacted crushed stone or slag
Underdrain
4" rolled slag or crushed stone sub-base
Track encasement placed in two cources
Paving brick 3"x4"x8½" laid 3" depth and 8½" dimension at right angles to curb
Half Cross Section
Normal 120' R.O.W.
Building line
15'
45'
36'
18'
45'
36'
15'
Building line
1" exp. joint
Joint
Joint
Expansion joints.
6" gas main
Water main
Light base
Detroit Edison conduit
Western Union conduit
Western Union conduit
P.L.C. conduit
16" steam main
Light base
12" gas main
12" water main
Section of New Woodward Avenue
1" batter in 7"
2" rad.
8"
7"
27"
Bend tie bar 90° at this point
6"
Cardboard tubing
36"
½"ϕ tie bars 48" long, spaced 5' c to c
½"ϕ bars
9"
Concrete Curb Special
3½" asphalt surface
¼" transverse joint
⅜" rad.
2½"
8"
10" concrete
Reinforcement
Plan of Weakness Joint
40'
Steel Reinforcement, Tie Bars and Joints in Concrete Curb
1½" asphaltic binder course
2" sheet asphalt wearing course
1⅛"
¼"
1" rad.
45°
2"
1"
Asphaltic Surface at Rails
100 lb A.S.C.T. section steel rail
Thermit welded joint
Steel tie
Spaced 5'-6" ave c to c
Crushed stone sub-base
Trench fill
6" vitrified tile
Longitudinal Section of Track

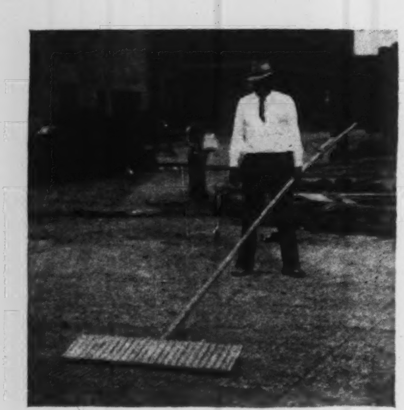


FIG. 7—SPECIAL FLOAT for corrugating surface of concrete base.

from 1,800- to 2,400-lb. stability and to contain 2 to 4.5 per cent voids.

Concrete base construction

Construction details relate specifically to the 0.68-mile section of pavement laid in 1934. Separate contracts were awarded (1) for concrete work (base, curbs and sidewalks) and (2) for sheet-asphalt surfacing. The concrete contract was awarded Feb. 8, 1934, but it was June 25 before mixing and placing actually began.

About ten companies, including the public utility corporations, had ducts buried in the old street, and until these ducts were moved the contractor could do little. Also temporary tracks for the street railway had to be laid down on one side of the work. On May 24, a paving breaker (consisting of a power shovel that dropped a heavy weight in guides at the end of its boom) began to demolish the old pavement, and on June 25 the contractor was able to start placing concrete track base, the first of the concreting operations.

The first course of the base, 5-6-5-in. thick and 18 ft. wide, was laid with a level top. After placing the track to accurate line and grade on granite blocks supported by this base and encasing the steel ties and rails in concrete, the contractor laid the adjacent pavement base in 18-ft. strips. A single 27-E paver employed on this work averaged 500 to 600 lin.-ft. of 10-in. base in 10 hours.

A batching plant consisting of two separate overhead bins and a combination storage and loading shed for sacked cement was erected on an unoccupied lot south of the railroad bridge. Materials were delivered to this plant by truck, and the bins above the weighing batchers were charged by a crawler crane. Batch trucks stopped at the cement platform after driving through the two bins.

As stated previously, two grades of concrete were required, one for the pavement base and the other for track encasement, with the richer mixture specified for the trackwork. Both mixtures used crushed slag as coarse aggregate. A typical batch of concrete for the track encasement contained 6 sacks of cement, 1,454 lb. of sand (with allowance of 3.9 per cent moisture), 791 lb. of coarse aggregate (2½ to 1 in. with 2.14 per cent moisture), 790 lb. of finer aggregate (1 to ¼ in. with 2.81 per cent moisture), and 255 lb. of water (31 gal.) after deduction to allow for moisture in the aggregate. A typical 6-bag batch of pavement-base concrete contained 1,706 lb. of sand (with allowance of 3.8 per cent for moisture), 901 lb. of coarse crushed slag (2.9 per cent moisture), 926 lb. of fine crushed slag (5.0 per cent moisture), and 234 lb. of water (28 gal.) after deducting for moisture in the aggregate. This mixture has a cement factor of 6.16 sacks per cubic yard.

Dry batches were delivered to a 1-yd. paving mixer that produced concrete for all purposes—track encasement, pavement base, sidewalk and curb. The base concrete was struck off and finished in 18-ft. lanes by a gasoline-powered finishing machine traveling on steel rail forms (Fig. 5). To provide a stronger bond with the asphaltic binder course, the surface of the concrete base was corrugated transversely with grooves ⅜ in. deep on 1½-in. centers. These grooves were formed by ⅛-in. round wires clamped on a 30-in. float (Fig. 7). Asphalt emulsion was sprayed on the concrete to seal the surface during the curing period. This asphalt application served also as a prime coat for the binder.

Sheet-asphalt construction

Sufficient base was completed by Aug. 24 to enable the contractor to start the binder and top course. The asphalt crew laid about 200 tons per night (equal to 1,140 sq.yd. of 1½-in. binder and 2-in. top), and an additional crew often was engaged in performing supplementary asphalt paving during the day. The brick parking strips were laid by a day shift.

The asphaltic mixture for binder and top were produced at a permanent asphalt plant situated on a railroad siding 7 miles from the Woodward Ave. contract. The asphaltic cement for the top mixture was blended from separate tank cars at this point. Trucks hauled 12,600-lb. loads (seven 1,800-lb. batches) of binder and 12,000-lb. loads (six 2,000-lb. batches) of top from the plant to the job. Binder mixture was delivered at between 225 and 325 deg. F., and top mixture at between 250 and 350 deg. F. The materials were dumped on the street and were turned over with forks before being struck off by the finishing machine.

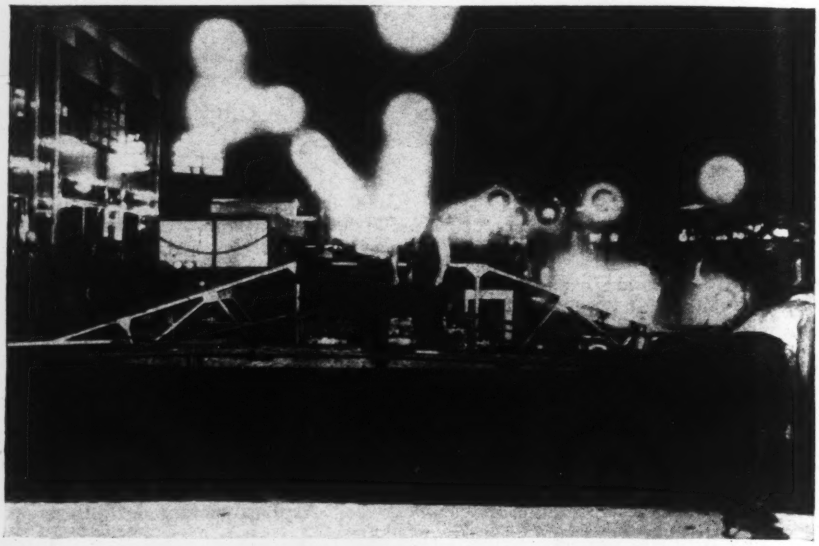


FIG. 8—NIGHT CONSTRUCTION of sheet-asphalt surfacing with 30-ft. finishing machine on widened Woodward Ave. in Detroit.

An old 20-ft. finishing machine was rebuilt to 30-ft. width by the contractor to strike off and screed, prior to rolling, both the binder and the top courses in the space between the outside rail of the streetcar track and the gutter. To take advantage of the absolutely true grade offered by the concrete-encased track rail, one end of the finisher traveled on this rail and the other end on a temporary rail laid on a 4-ft. strip of hand-placed binder. Night operation was necessary to avoid undue interference with street-railway service.

In rebuilding the finisher, the paving company introduced specially cut reducing gears in the mechanical drive to give the desired forward speeds and the proper number of screed strokes per minute for the two asphaltic courses. These values were worked out as the result of actual experience on the pavement. For the 1½-in. binder course, a forward speed of 5½ to 6 ft. per minute and 65 to 70 screed strokes per minute proved effective. On 2-in. sheet-asphalt top, a much slower forward speed of

31 in. per minute and an equal rate of screed oscillation (65 to 70 strokes per minute) were required for a plane surface that would be free from waves and checks.

To propel the heavier machine at a uniform speed, a third traction wheel was added at each end. Compression plates, channel-shaped to fit the rails and equipped with pusher wheels to bear against the forward traction wheels of the finisher, were used under both ends of the screed to provide excess depth of asphaltic materials as allowance for compaction under the rollers. Difficulty occasionally was experienced as a result of the compression plate's sticking on the thermit-welded joints of the steel streetcar rails.

A tubular truss supported the 30-ft. screed near its third points by two turnbuckle hangers. Adjustments in the crown of the screed could be made readily by twisting the turnbuckles without stopping the motion of the screed. A steel angle bolted to the bottom of the screed struck off the binder course at the desired depth below the top of the rail.

Three steam rollers, of 10- to 12-ton weight, and a smaller more flexible gasoline-powered roller compacted the binder and sheet-asphalt courses behind the finishing machine, rolling the pavement both longitudinally and transversely. The pavement was held rigidly to a specification limiting surface irregularities to $\frac{3}{16}$ in. in 10 ft. Inspectors checked the top with 10-ft. straightedges.

Work was in progress on only one side of the street at a time. The street-railway organization lighted (Fig. 8) the side under construction for perhaps 1,500 ft. by three overhead lines of 500-watt lamps. These lamps were installed in pairs 50 ft. apart. In addition, the paving crew was supplied with a portable set of six 600-watt lamps (equipped with reflectors), which tapped into the unused trolley wire of the railway; and the new street-lighting system for Woodward Ave., already in service, added a share of illumniation.

Brick paving

Vitrified paving brick in the 6½-ft. parking strips adjacent to the curbs were laid by a day shift on a ½-in. compacted depth of mastic cushion composed of 92 to 95 per cent (by volume) clean dry sand and 5 to 8 per cent asphalt cutback. The joint filler for the brick pavement was a pure asphalt applied at about 350 deg. F. Before applying the filler, the crew sprayed the surface of the bricks with a calcium chloride and starch solution, which prevented bonding of the asphalt to the top of the pavement and permitted easy removal of the excess asphalt. The solution was made up in the following proportions: calcium chloride, 100 lb.; water, 25 gal.; starch, 3 lb. In hot weather the proportion of starch was increased. It was considered that brick parking lanes in asphalt-street construction eliminate softening of the asphalt surface caused by oil drippings from parked cars, and mark definitely and decisively the only areas in which motorists may legally leave their vehicles.

Special construction details

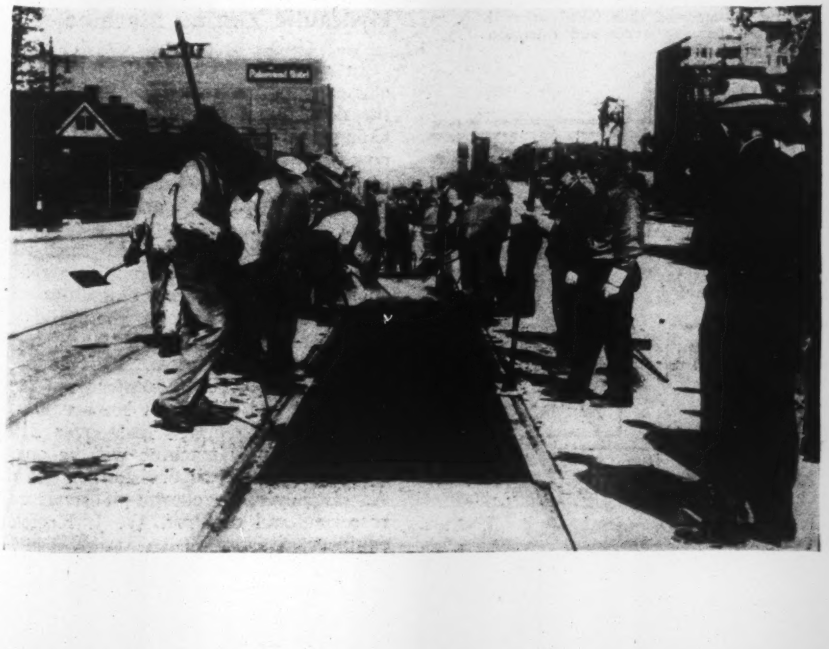
A V-shaped cut was made in the existing asphalt surface of all intersecting side streets. By putting the joint on diagonal lines, where the wheels of a passing vehicle would not strike it simultaneously, the state highway engineers hoped to avoid any sensation of bumpiness which a rider may experience at a right-angle transverse joint, no matter how carefully it is straightedged and rolled. A similar diagonal joint was made in the sheet-asphalt wearing surface on Woodward Ave. between successive runs.

Effort was made in paving between the rails to develop a groove that would not accumulate dirt and result in cutting and disintegration under the flanges of the streetcar wheels. Special tools and equipment were devised to construct a groove meeting the requirements. Fig. 9 illustrates some of these tools and the method of paving between the rails. A special iron also was forged to form a smooth shallow depression along the outside of the rail, in the hope that this clean surface junction would eliminate most of the surface checking adjacent to the rail.

Direction

Murray D. Van Waggoner is state highway commissioner of Michigan, and Harry C. Coons is deputy commissioner and chief engineer. The Woodward Ave. paving project was designed and carried out under the general direction of V. B. Steinbaugh, road engineer. The contractor for the concrete work was the J. A. Mercier Co., Detroit, and for the asphalt surfacing was the Detroit Paving Co., Detroit.

FIG. 9—LAYING SHEET ASPHALT between rails in paving Woodward Ave.



* * *

Two New 1,000-Ft. Piers for Hudson River

CONSTRUCTION of one of two proposed new 1,000-ft. piers to be built by New York City and leased to the Eastern Steamship Lines was begun on April 8. The new piers will occupy the site of present Piers 24, 25 and 26 on the Hudson River between North Moore and Franklin Sts. After completion of the substructure, the steamship company will proceed with construction of the superstructure.

The new piers will each be 1,000 ft. long; Pier 25 will be 125 ft. wide; Pier 26, 135 ft. wide. Pier 25 will be a single-story pier, while Pier 26 will have an upper level running for half its length.

A two-story bulkhead structure for offices and passenger facilities will be built on the street end to connect the two piers. The slip between the new piers will be 137 ft. wide.

Contract for removing the old piers and for the construction of the substructure of new Pier 25 is held by J. Rich Steers, Inc., New York.

Construction of these two new piers will give the Manhattan waterfront six new berths. The three 1,100-ft. piers between 48th and 52d Sts. are nearing completion in readiness for the arrival of the French Line's "Normandie" on June 3 and of the Cunard-White Star's "Queen Mary" soon after. A similar 1,100-ft. pier, being built at Canal St., is leased to the North German Lloyd line for docking the "Europa" and the "Bremen."

Splicing a Locomotive Crane Boom to Handle 75-Ft. Sheetpiling

By W. G. Cheever
General Manager, Blakeslee-Rollins Corp., Boston, Mass.

IN ORDER to be able to thread 75-ft. lengths of steel sheetpiling in constructing two foundation cofferdams for a vertical-lift railway bridge over the Cape Cod Canal (*ENR*, Jan. 3, 1935, p. 1), it was necessary to devise some type of extension to the booms of two locomotive cranes. The extensions developed were built-up sections of 2½x2½x3/16-in. angles and 2x2x3/16-in. lacing bars and, when erected, were stiffened on top, bottom and both sides by trussing cables and outriggers (Fig. 2).

The final length of boom was such that when raised to maximum height the hoisting fall sheave was 147 ft. above track level, enabling the contractor, after some preliminary excavation, to place and thread the sheeting without undue difficulty.

The extension for the first crane was erected with the boom in a horizontal position, and the extension was seated on the lapped end of the crane boom for a distance of 7 ft. (Fig. 1, top). However, this arrangement of splicing, when tested, proved unsuccessful since, due to elasticity in the top trussing cables when fully loaded, unexpected stresses were introduced at the point of splice and brought about failure in the bottom chord of the extension.

After this failure the splice was changed, so that the only contact between the bottom chord of the extension and the top chord of the crane boom was at the inboard end of the extension, where a heavy channel section formed the connection (Fig. 1, bottom). The top trussing cables were taken up sufficiently so that when fully loaded a clearance of 2 in. existed between the top chord of the boom and the bottom chord of the extension at the point of splice. A 2-in. turnbuckle was then placed between the connecting channel and the end of the crane boom, to take the end thrust.

The trussing cables were all carefully adjusted by turnbuckles. The top trussing cables consisted of two pairs, which were attached to the crane boom close to the foot, thence carried over a saddle or outrigger at the splice, from which point one pair of 1-in. cables ran to the end of the extension and one pair of ¾-in. cables ran to a point on the extension about 24 ft. from the splice. In a similar manner the bottom and both sides were trussed with ⅞-in. wire rope, to take any backlash due to sudden strains on the hoisting falls when threading the sheeting. The outriggers extended out from the center line of the boom for a distance of 7 ft.

The boom falls on the crane boom was not disturbed at any time, it being only necessary to remove the hoisting-fall sheave and guard.

After attaching the extension in a horizontal position, it was found necessary to make use of another crane to raise the boom sufficiently above the horizontal, to enable the crane to handle it safely. In handling loads the boom was never lowered outside a radius of 36 ft. or an angle of 75 deg. with the horizontal. (The cranes had a capacity of 15 tons at 25-ft. radius with the normal boom.) Special 12x75-lb. I-sections were installed under the frame of the crane and blocked to prevent overturning. Careful attention was given to the selection of a capable and conscientious operator, as any severe handling of the rig might cripple its usefulness. The extensions were designed by R. J. Reigeluth, of C. W. Blakeslee & Sons, contractors, and Mr. Ahrens, of the New England Iron Works.

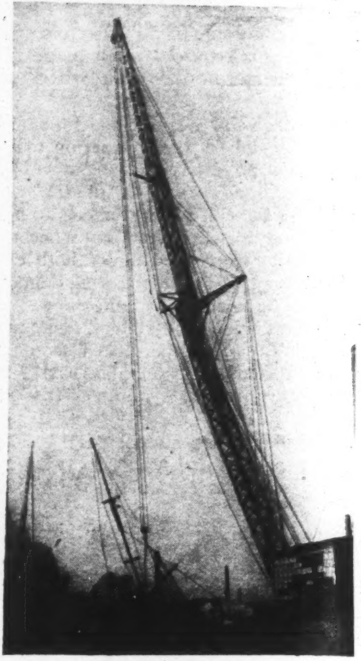
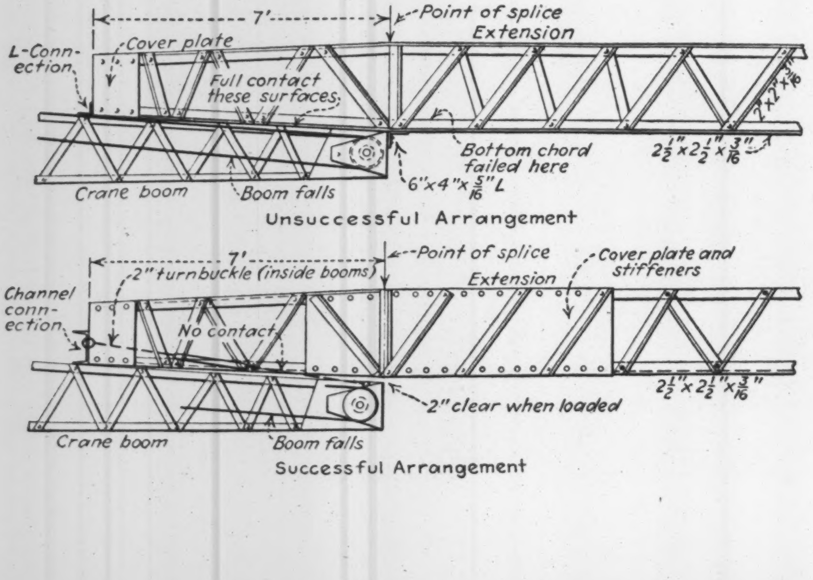


FIG. 2—CRANE-BOOM extension reaching to nearly 150 ft. above the ground, in order to handle 75-ft. steel sheetpiles for a cofferdam.

FIG. 1—DETAILS OF BOOM SPLICE, showing arrangement that failed as well as the one that proved successful, in which contact between boom and extension was confined to inboard end of extension.



* * *

Columbia University Buys Large Hydraulic Testing Machine

In order to increase the scope and efficiency of its materials-testing work, the department of civil engineering of Columbia University has purchased a new 1,000,000-lb. universal hydraulic testing machine, which will be the largest in the New York metropolitan area.

The machine weighs 45 tons and will be 40 ft. high. It occupies a space about 50 ft. square, extending up through four stories of the building. Specimens 6 ft. wide and 20 ft. high may be accommodated. The machine replaces a 400,000-lb. compression machine that had a capacity for specimens only 7 ft. long and a little over 2 ft. thick. The new machine will be operated under the supervision of Prof. A. H. Beyer, in charge of structural research, and of Prof. W. J. Krefeld, engineer of tests.

From Job and Office

Coordinate Method of Computing Irregular Cross-sections

By John C. Park
Associate Professor of Civil Engineering, University of Arizona, Tuscon, Ariz.

In using the coordinate method of computing areas of irregular cross-sections, confusion regarding algebraic signs can be eliminated if the method described herewith is used.

Divide the cross-section into two parts by the center line and compute each part separately. Use the base and center line as the coordinate axes for each part. List down as coordinates the cross-section notes for one side exactly as they were taken in the field, and add to them the coordinates of the base at center and edge. Consider all coordinates as plus when computing either the right or the left side of a section in cut or a section in fill.

For example, take the section shown in the accompanying sketch. The cross-section notes would be

$$\frac{22}{+8}\quad\frac{13}{+9}\quad\frac{2}{+3}\quad\frac{0}{+4}\quad\frac{6}{+5}\quad\frac{12}{+4}\quad\frac{19}{+6}$$

Starting at the center and going around the half-section in a clockwise direction, the coordinates of the right side would be

$$\frac{0}{4}\quad\frac{6}{5}\quad\frac{12}{4}\quad\frac{19}{6}\quad\frac{10}{0}\quad\frac{0}{0}$$

Starting at the left side and going around the left half-section in a clockwise direction, the coordinates would be

$$\frac{22}{8}\quad\frac{13}{9}\quad\frac{2}{3}\quad\frac{0}{4}\quad\frac{0}{0}\quad\frac{10}{0}$$

It will be noted that these coordinates can be written down directly from the field notes without plotting the section.

Following the rule of numbering the corners consecutively around the field, multiplying each ordinate (or abscissa) by the difference between the preceding and the following abscissas (or ordinates) always subtracting the preceding from the following (or always subtracting the following from the preceding), and taking half the algebraic sum of the products, we have, for the right side

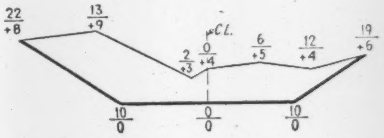
$$\begin{array}{lrr}
4(0-6) = & & -24 \\
5(0-12) = & & -60 \\
4(6-19) = & & -52 \\
6(12-10) = & 12 & \\
0(19-0) = & 0 & \\
0(10-0) = & 0 & \\
\hline
 & 12 - & 136 = 124,
\end{array}$$

which when divided by 2 equals 62.

It will be noted that the process of listing these six equations for computation is laborious and likely to cause error if each equation is listed separately. However, if the figures are listed in column, the process becomes rapid and errors unlikely. Note, in the computations above, that the first column is the same as the lower line of the coordinates. The second column is the same as the upper line of the coordinates, beginning with the last figure, which is zero. The last column is the same as the upper line of the coordinates, beginning with the second figure, which is 6.

From the rule stated above it is apparent that if we list the coordinates consecutively, we can begin at any corner of the half-section and go around it in either direction and obtain the correct result. Ample opportunity is therefore afforded for checking.

The sign of the final result will depend upon the direction in which the coordinates are listed. It is, of course, disregarded.



CROSS-SECTION of cut, area to be determined by coordinate method.

If it is desired to use the cross-multiplication method, the problem is even simpler than that given above. The coordinates for the right side should be listed exactly as shown above, and the multiplications performed mentally. We write down the products as follows and add:

$$\begin{array}{lr}
24 & \\
60 & \\
76 & \\
60 & \\
 & -24 \\
 & -72 \\
\hline
220 & -96 = 124
\end{array}$$

which, when divided by 2 = 62.

It will be noted that it is unnecessary to repeat the first coordinate $\frac{0}{4}$ at the end of the line of coordinates, as is common practice for this method. The zero factor, which is always present, makes this repetition unnecessary.

It may seem that the making of two problems out of one will greatly increase the labor necessary to obtain the results. However, this apparent increase in labor is offset by the presence of numerous zero factors and the possibility, which the method affords, of doing most of the work mentally.

The method has the further advantage of simplicity, as it is not necessary to follow any rule regarding algebraic signs or to make any additions in order to transform cross-section notes into coordinates. The method can be used without plotting and is fairly rapid in the field for both regular and irregular sections.

Take the following cross-section:

$$\frac{19}{6}\qquad\frac{0}{4}\qquad\frac{13}{2}$$

The coordinates of the right half-section are $\frac{0}{4}\ \frac{13}{2}\ \frac{10}{0}\ \frac{0}{0}$, and the area of this half-section is 2 × 13 + 1 × 10, which is simple mental arithmetic. The coordinates of the left half-section are $\frac{0}{0}\ \frac{10}{0}\ \frac{19}{6}\ \frac{0}{4}$, and the area equals 3 × 10 + 2 × 19.

The illustrative problems given here have dealt with the whole numbers only. Obviously, when decimals are involved, the labor will be increased. This also holds true for any other method and consequently does not affect the comparative merits of this method.

Compacting Highway Fills in California

Greater attention is being given to the compaction of highway embankment, states C. S. Pope, construction engineer, in the last report of the division of highways, California department of public works. The practice is growing of specifying the density of the embankment rather than the type and weight of equipment to be used. When density is specified, it is required that the amount of material after drying within a unit of space in the completed embankment shall be compacted not less than 90 per cent of the amount of material which would be compacted in a like unit in the laboratory under specified and controlled conditions. In the laboratory the material is dried, weighed, moistened and consolidated in a cylindrical mold 6 in. in diameter and 8 in. high under a load of 2,000 lb. per sq.in.

Various methods are being tried to avoid the erosion of wide embankment slopes, one of these being the insertion of level brush mattresses along the edges of the embankment at vertical intervals as the embankment is constructed.

If pipe culverts 24 in. or more in diameter are installed in embankments, the embankment is constructed and consolidated to a depth of 2½ ft. and then trenched for the pipe. For pipe less than 24 in. in diameter, embankments are constructed to 6 in. above the proposed top of the pipe before trenching.

When selected or imported materials are used to top embankments or to replace the natural material as a foundation in cuts, the compacted material is required to have a predetermined definite bearing value.

Uniform compaction of embankments throughout all state highway construction is obtained by requiring each resident engineer to use a field-testing outfit for the determination of the degree of compaction. Under such control, trench backfills, bridge approach fills and embankments can be built with little likelihood of appreciable subsequent settlement. As a result of this uniformity of practice, contractors have been able to develop and use heavier and more efficient grading equipment.

Designing Concrete Members for Bending and Compression

By F. E. Turneaure
Dean, College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.

THE PROBLEM of the analysis of unsymmetrically reinforced-concrete members subjected to bending and compression and with tension on one side of the section has been given considerable attention from time to time, and various solutions have been proposed. The problem of design for specified working stresses is relatively simple, as the position of the neutral axis is known, and formulas and diagrams can readily be developed to aid in the work. The simplest method is probably to calculate the capacity of the beam without compression reinforcement, and then to make up the deficiency in strength by compression reinforcement and additional tension steel, the steel stresses acting with a moment arm equal to their distance apart.

For the problem of the analysis of a given beam, the following method is suggested as being advantageous; it is quite probable that this method has occurred to others, but I have not seen it in print, and in view of the increasing use of the rigid-frame structure where such problems frequently arise it seems worth while to point out its simplicity and the procedure that will quickly arrive at results:

1. Find by trial calculations the value of N and f_s corresponding to any selected value of f_c.
2. Find by simple proportion the stresses due to any given value of N, or the safe value of N for any given working stresses.

The trial calculations can be made very quickly, and with a little experience more than two calculations will seldom be necessary.

Example—Assume data as follows: $b = 10$ in., $d = 20$ in., $e_1 = 30$ in., $d' = 2$ in., $n = 15$; limiting stress values, $f_c = 800$ lb. per sq.in., $f_s = 18{,}000$ lb. per sq.in., $A = 1.5$ sq.in., $A' = 1.0$ sq.in. Find stresses for $N = 25{,}000$ lb. and also safe value of N.

Assume $f_c = 800$ lb. per sq.in., and for the first trial assume $f_s = 18{,}000$ lb. per sq.in., although this is evidently too high.

Then $f_s/nf_c = 1.5$, $k = 0.4$, $j = 0.867$, $kd = 8.0$ in., $jd = 17.33$ in., $f'_s = 800 \times 15 \times \frac{6.0}{8.0} = 9{,}000$ lb. per sq.in.

C = compression in concrete $= 800 \times \frac{1}{2} \times 10 \times 8 = 32{,}000$ lb.

C' = compression in steel $= 9{,}000 \times 1 = 9{,}000$ lb.

Total compression $= 41{,}000$ lb.

Moment of C about tension steel $= 32{,}000 \times 17.33 = 555{,}000$ in.-lb.

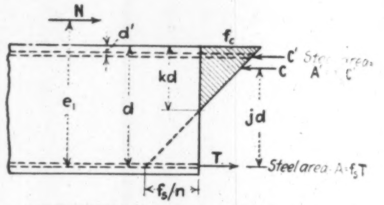
Moment of C' about tension steel $= 9{,}000 \times 18 = 162{,}000$ in.-lb.

Total moment $= 717{,}000$ in.lb.

$N = 717{,}000/30 = 23{,}900$ lb. $T = 41{,}000 - 23{,}900 = 17{,}100$ lb., and $f_s = 17{,}100/1.5 = 11{,}400$ lb. per sq.in. The correct value of f_s will lie between 18,000 and 11,400.

A second trial with $f_c = 800$ and $f_s = 14{,}000$ leads to a value of $N = 26{,}500$ and $f_s = 13{,}300$.

A third trial with $f_s = 13{,}500$ gives $N = 26{,}800$ lb., and $f_s = 13{,}500$ lb. per sq.in., which is the desired solution.



NOTATION for concrete beam with both tension and compression reinforcement.

The stresses for $N = 25{,}000$ lb. are as follows:

$f_c = 800 \times 25/26.8 = 745$ lb. per sq.in.

$f_s = 13{,}500 \times 25/26.8 = 12{,}600$ lb. per sq.in.

The safe value of N is evidently 26,500 lb.

If the amount of the tensile steel had been 0.7 sq.in., the same process leads to a value of $f_s = 21{,}800$ lb. per sq.in., and $N = 21{,}800$ lb. The safe value of N is $21{,}800 \times \frac{18}{21.8} = 18{,}000$ lb., and

$$f_c = 800 \times \frac{18}{21.8} = 660 \text{ lb. per sq.in.}$$

Reactions at Pipe Bends in Water-Distribution Systems

By Irving Goldfien
Senior Engineer, Milwaukee Water Department

DURING the past five years the city of Milwaukee has been designing and constructing a high-pressure water-distribution system to be used for fire-protection purposes, and in such work the municipal water department has been called upon to furnish all the engineering services. Among the duties assigned to the author was the design of anchors at all bends in the pipe line.

The system being constructed is to be operated under a pressure of 300 lb. per sq.in., and the test pressure for acceptance of construction work is established at 450 lb. per sq.in. The size of pipe used in the distribution system to date ranges in diameter from 12 to 20 in., and a large number of bends occur throughout the system.

Computations for reactions at pipe bends can be computed from the combined formula for static and dynamic forces: $E = 2A\left(P + \frac{WV^2}{g}\right)\sin\frac{\theta}{2}$. But this requires a separate calculation for each condition, varying with pipe cross-section area, hydrostatic pressure, velocity and deflection angle of the bend.

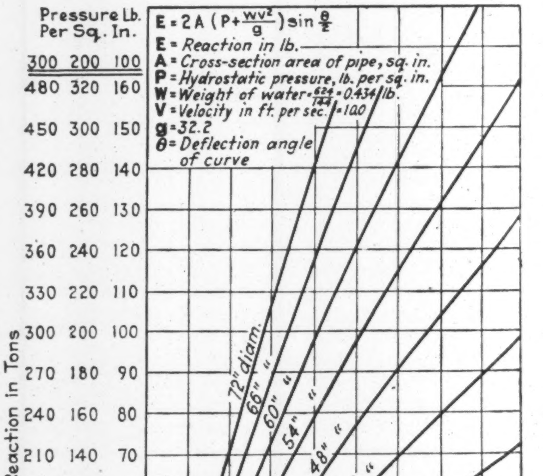


DIAGRAM for determining reaction at bends in water-distribution system.

As a substitute the author devised the accompanying diagram which permits the direct determination of the reaction for any given conditions under an assumed average velocity of 10 ft. per sec. Any deviation from the assumed velocity does not appreciably affect the final result.

The chart gives the reactions for all ordinary conditions, using pipes ranging from 12 to 72 in. in diameter. Assume that the reaction of a 45-deg. bend in a 36-in. pipe line under a pressure of 250 lb. per sq.in. is required: tracing the 45-deg. deflection-angle line up to an intersection with the 36-in. diameter line and thence to the left, we determine a reaction of 39 tons for a 100-lb. pressure; multiplied by 2.5, this gives 97.5 tons as the desired reaction.

The chart saves a great deal of computation and was used in determining the designs of all anchors at bends in the aforementioned system. It is being used daily in all designs of the Milwaukee water department.

Letters to the Editor

A.R.E.A. Bridge Impact Formula

Sir—In your issue of March 21, p. 426, you mentioned my discussion of the impact formula adopted in the new A.R.E.A. specifications for steel railway bridges. Your review, because of its brevity, is perhaps unavoidably misleading. The point that was omitted in your report, and was not sufficiently emphasized at the actual discussion, is that the synchronism which causes high impact values at low speeds occurs only on long spans that have a relatively low frequency of vibration.

By far the great majority of spans in cities are over streets, and are plate-girder or beam spans that have high frequencies. For such spans reduction of speed does, as a matter of both theory and fact, result in a reduction of impact.

The trouble with the new impact specification of the A.R.E.A. is that it is designed, primarily, to give impact values for truss spans; whereas about nine-tenths of the tonnage in steel railway bridges consists of beam and girder spans. Thus, in the zeal to get an all-inclusive and simple formula, the opportunity distinctly to improve the formula for the important majority of spans was entirely missed.

THEODORE DOLL,
Ass't. Engineer, Bridge Dept.,
A.T.&S.F. Ry. System.

Chicago, Ill.
March 28, 1935.

Brick Canal Lining in Colombia

Sir—We are very much interested in W. I. Gilson's article, "Brick Lining for Irrigation Canal in Texas," which was published in your issue of Aug. 23, 1934.

It may be of interest to some of your readers to know that the Magdalena Fruit Co. up to the present time has constructed 32,000 square meters, or 12,500 linear meters, of brick-lined canals in Colombia, South America.

The conditions that brought about our decision to use brick lining were local. The old earth canals had been in operation for years and were located on sand ridges. Naturally the seepage losses were considerable, in many cases running as high as 30%. Furthermore, the normal dry season in the river was not sufficient to allow us to irrigate adequately the dependent area of appriximately 4,000 acres of bananas. The only solution to this problem was lined canals, thereby eliminating the seepage losses and placing the water under better control. The problem of lining these canals was thoroughly studied in 1932. Concrete lining was immediately discarded because the initial cost of cement plus ocean freight and a large import duty made its use in canal lining prohibitive in our particular case. Moreover, preliminary estimates showed that it would be cheaper to use national products if available.

A survey of the small hand-labor brick factories in this vicinity indicated that we would not obtain enough brick within a reasonable length of time to meet our requirements. Therefore a modern brick factory was erected in 1933 with a manufacturing capacity of 500,000 brick per month. This allowed us to start the brick lining during the latter part of 1933.

Our method of installation was practically the same as that described by Mr. Gilson, and made use of the hoe to complete the finished grading. When the lining was first started two small sections were laid with Colombian size brick—i.e., $2\frac{1}{8}$x$5\frac{1}{4}$x$11\frac{1}{2}$-in. The use of this large-size brick was soon discontinued because the standard American size brick was found to be more practical. Great difficulty was encountered in laying the large brick in the circular sections, especially when the radius of the canal was small. Moreover, the amount of mortar used per square meter of lining was exactly the same irrespective of whether the large or the small-size brick was used. This was due to the large brick being more irregular, necessitating a larger joint.

The mortar used at the beginning of the job was a 1:3 cement mix. Later on we changed to a 1:3 lime mortar with 10 per cent cement. This mortar was decided upon because the lime could be bought locally and proved more economical than cement. Experience has proved that very good results can be obtained with lime, and that the longer it sets the harder and stronger it becomes.

The entire project was laid by troweling, the course in the bottom of the canal being laid first; the brick was left unfaced, not being covered with a thin mortar.

The two years' experience that we have had with brick-lined canals indicate that they are superior to canals lined with 1 or 2 in. of concrete. We have found no signs of deterioration or failure. This is true in spite of the fact that water was turned into the canals a few hours after they were lined in order to carry on irrigation. The canals are of the circular type and vary in diameter from $3\frac{1}{2}$ to 13 ft. All sections are standing up very well.

The brick-lined canals have a decided advantage over other types of lined canals because of their simplicity of construction. No mechanical equipment is required. They can be constructed with the least amount of technical and skilled supervision. Our entire program of brick lining was done with one resident engineer and one foreman.

The following are the costs per square meter of canal surface taken over the entire job of 32,000 sq. m.:

Engineering and supervision	$0.0687
Cleaning right-of-way	0.0219
Truck roads	0.0416
Excavation	0.1011
Fine grading	0.0797
Hauling materials	0.0402
Laying brick, including cost of materials	0.6530
Miscellaneous	0.0651
Total cost per square meter	$1.0713
Total cost per square foot	$0.0995

E. M. CRAWFORD,
Chief Engineer,
Magdalena Fruit Co.

Santa Marta, Colombia,
March 13, 1935.

Cement Coefficients —A Correction

Sir—In the third column of coefficients of portland cements, p. 424, March 21, there appears an omission of one line, and also an error in one of the coefficients, where I have given the short table as follows:

	Coefficient of
Standard cement, aver. of 9 months	.0000093
Standard cement in Ca Cl_2 dessicator 1 week	.0000105
Standard cement in water 1 week	.0000080
Standard cement in steam 1 week	.0000066

In print, the line "Standard cement in water 1 week," does not appear at all, and the coefficient .0000080 appears in place of the dry-storage coefficient .0000105.

The above has made the coefficient results appear opposed to the conclusions contained in the manuscript.

S. L. MEYERS,
Southwestern Portland Cement Co.

El Paso, Tex.,
March 30, 1935.

ENGINEERING NEWS-RECORD

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April 18, 1935

Constructive Counsel

THE GOVERNMENT is not likely to find a better way to insure the success of its new works program than to adopt the recommendations just made by the Construction League with the endorsement of Construction Code Authority. These recommendations are an important contribution to the problem of making the program effective for recovery. Resting on long practical experience in carrying out construction projects, they deal wisely and fairly with the question of how best to handle design, field execution, purchase and labor employment. The interests of government and of labor are protected with equal care. Because of their fairness the recommendations, if adopted, would give maximum encouragement to private initiative, and would thereby provide assurance that the stimulative influence of the works program will spread out through the country's activities far beyond their immediate place of operation. The proposal contained in them for cooperation with the NRA system is equally constructive. In short, the recommendations would go far toward guaranteeing greatest economy in the expenditure of the four billion dollars and avoidance of the risks in inequity and disruption.

Eliminate Building Parasites

THE RECENT PROTEST of the National Association of Real Estate Boards against continuation of the construction industry code on the ground that it had slowed up housebuilding by causing a considerable increase in the cost of such work serves to turn the spotlight on one of the chief causes of the ills of the construction industry. Irresponsible speculative housebuilders long have demoralized an essential business through get-rich-quick methods that left the purchaser of their shoddy houses holding the bag. By fostering usurious rates for second-mortgage money, by increasing the risk of the purveyors of building materials and by disorganizing established agreements for the payment of labor, they have forced up housebuilding costs and have limited the field by giving support to the belief that it was cheaper to rent than to buy your own home. The National Association of Real Estate Boards, by urging that housebuilding be excluded from the provisions of the construction code, is playing into the hands of the worst elements in the construction field. If it really has the best interests of the housebuilding industry at heart it should help rather than hinder a movement that has promise of eliminating the parasites.

Accomplishment at Fort Peck

WITH THE HOLING THROUGH of three of the pilot bores of the great river diversion tunnels for the Fort Peck Dam and less than a week's work remaining on the fourth, the first chapter has been written in one of the large tunneling operations of recent times. Together these four tunnels aggregate nearly five miles in length through a curiously unstable rock that has had to be protected and heavily timbered every foot of the tunnel length. In barely nine months since work was begun the contractors have driven not only this great length of 16¼x14-ft. tunnel but also made a large volume of preparatory earth excavation. On any count this a record of efficiency in procedure and management beyond common experience, one that augurs well for the more hazardous tasks of enlarging the rock bore to its final 32-ft. diameter and installing the 3-ft. lining of concrete and steel plate. While the technique of equipment and working methods have a prominent place in the accomplishment, their main significance is that they typify the spirit and energy of the high-pressure construction activities on this greatest of earth-dam operations. In the seventeen months since the first handful of laborers began clearing the site, every one of the multitudinous processes of construction and of servicing construction has held to a pace that represents a triumph of construction engineering skill and energy.

Concreting Methods Compared

THE PLACING of more than 600,000 cu.yd. of concrete in the seven Mississippi River navigation works described in this issue presents a unique opportunity for comparison of methods and equipment. All the structures are substantially alike in design and not greatly different in volumes of work and in working conditions. Virtually the only opportunity for variation remained in the conceptions by different contractors of the plant and methods to be preferred in producing and placing the concrete. It is curious to note how few differences are shown when equipment and procedure are ranged side by side for the seven operations, and how closely the average hourly rates of output agree. In large measure this may be attributed to a common specification for weight proportioning, time of mixing, and placing by internal vibration, but the similarity is equally due to an increase in the standardization of concreting methods that is universal. Today there is difference only in detail in concrete mixers and in batching equipment; form construction shows no fundamental differences, and the same is true of devices for internal vibration. Choice of equipment and methods finds its greatest freedom in the processes of transporting the concrete from the mixers to the forms. Few comparisons show more clearly than the tabulations in this issue the degree to which concreting operations are approaching standardized excellence.

The Future of Brooklyn Bridge

FOR THIRTY YEARS Brooklyn Bridge in New York has been waging a losing battle against increasing traffic demands, and today the structure is hardly more than a sentimental landmark. Its history reveals also a record of municipal parsimony and of valiant attempt on the part of the engineers charged with its maintenance to keep it in safe repair with meager funds in the face of mounting repair costs. The time is at hand when economy alone will counsel that the bridge be rebuilt. On such background is projected a highly interesting proposal to modernize the historic structure. The imposing towers that give the bridge its distinctive character would be retained, as well as cables and anchorages, but the entire suspended structure would be replaced by one built of structural aluminum alloy to modern type and of large traffic capacity. Altogether the project as presented on another page constitutes a fascinating invitation for immediate consideration of the rebuilding problem. It is not the only design possible, and on final analysis may not prove the best for the purpose, but it obviously challenges careful study. There will undoubtedly be a strong tendency to question it as a radical innovation, but in fact its originality is a favoring argument rather than a point of doubt, for boldness in making use of new possibilities has ever characterized major bridge achievement, as witness the alloy-steel tube arches of the Eads Bridge, the structural make-up of the Forth, the thin ribs of recent European long-span concrete arches, or indeed the original conception of Brooklyn Bridge itself. In the present case the proposal is supported by service experience in the floor of the Smithfield St. bridge in Pittsburgh, as well as in hoist booms and cranes—substantial support especially as the Brooklyn Bridge proposal involves no main carrying members. Regardless of whether the proposal succeeds in meeting the challenge of alternative plans, it merits recognition as a highly original contribution to bridge engineering thought.

The Issue of Recovery

The four billion dollars works act—officially the Emergency Relief Appropriation Act of 1935—is soon to be put into operation. Its purposes have been beclouded by the stress laid on relief, and the long Congressional disputes on minor points have obscured its real difficulties. As a result it has been little understood. In particular its relation to industry has been almost wholly overlooked.

This is the second attempt to put construction to use in promoting recovery. There is not likely to be a third attempt if the present one fails. Banker and manufacturer therefore are just as deeply concerned in it as the unemployed work-relief applicant. Its importance to them lies in the fact that failure would fasten on the country a relief burden heavy enough to block progress for an indefinite time.

Four billion dollars is a sum so far beyond the comprehension of most of us that its effective magnitude is not easy to grasp. It is a huge sum indeed, yet small compared to what it must accomplish. In terms of men returned to useful production it means, if expended within a year and properly expended, some three to four million men—on the job, in mill or railroad service, in store or office. This is all that the act can accomplish directly, even with the improbable 100 per cent efficiency in application. But twice as many men will still remain idle, and unless they also find normal wage opportunity we are not likely to progress far in recovery. To employ these is the job of private enterprise.

Let us look at what the government is likely to accomplish directly. The recent announcement of early start on grade-crossing improvement indicates that the necessity for speed has at last found recognition at Washington; a hopeful sign. Roads and grade-crossings are sure to make a quick start and to maintain the pace. They account for roughly one-fourth the total of the fund appropriated by the act. City and state projects will account for another fourth, but only if thoroughgoing change in procedure permits them to get going quickly. These items of assured speed make up half the total.

Of the other half, part is destined to relief, including the Civilian Conservation Corps and "rural rehabilitation in stricken areas," while the remainder goes to such operations as rural electrification, housing, irrigation and flood control, all of them unavoidably slow to get going. Whatever their merit, all these uses are either sterile for recovery or will be too slow in application to provide a strong starting impetus. Thus it appears certain that the prospects of constructive wage-earning expenditure during the year are limited to half the total appropriation, which means less than two million men employed. Even this figure will be further reduced through the formidable difficulties of executing the act.

Critical difficulties lie in the magnitude of the operation, in the necessity of obtaining speed, in the diversity of work to be undertaken and its necessary coordination with employment and industry's needs. Others are certain to appear in overlap of jurisdictions and in the political and personal problems of organizing. Finally, not least of the difficulties is that which arises from the mixed purposes of the act. Relief and recovery, though identical in ultimate purpose, are largely incompatible as to method; the social worker's relief attitude is bound to clash with constructive recovery effort.

Major hazards that confront the campaign must also be taken into account. Among them is the desire of various groups to divert money from the fund or to promote blue-sky schemes that are more likely to discourage than to upbuild. Another is political greed and demand for pork distribution—already become audible. Still another is the acquired habit of dependence by taxpaying communities. And by no means negligible is the risk that the administration may wreck its own campaign by failing to make full use of existing business agencies to sustain and spread the recovery influence.

It is clear that the combined effect of these factors is to make the problem of organizing the gigantic undertaking and maintaining sound policies even more serious than its size alone would imply. For this reason the estimate of two millions of re-employment may be cut to not much more than a million. Industry's job in supplementing the direct operations of the act then becomes still greater.

Without industry's full cooperation, in short, the act will not succeed. In this very fact, however, there lies a significant opportunity for the business man and the enterpriser. This situation offers large direct advantages superadded to the opportunity of ensuring his future by contributing to the success of the recovery campaign. Costs are rising and promise to rise further as operation of the act gets into full swing. Rebuilding or expansion carried out now will therefore prove cheaper than if postponed. Costs aside, however, the enterprising man who rebuilds and expands will have a clear advantage over his more conservative competitor if the campaign succeeds, while if it fails he will not be the loser, for then the venturesome man and the ultra-conservative will be in equally hard straits.

Government and private business thus are jointly concerned in assuring the successful outcome of the operation of the act. The President has the heavy responsibility of organizing a task of unprecedented magnitude and shaping its governing policies so wisely as to avoid the hazards that threaten its successful accomplishment. Private enterprise has the even larger responsibility of mobilizing its initiative to take full advantage of the recovery impetus and to carry out that major fraction of the work which the act itself cannot accomplish. It is significant and encouraging that in assuming this responsibility business runs no risk; the advantages of cooperation are wholly in its favor.

CURRENT NEWS

Construction Code Extension Asked By Code Authority

EXTENSION of the National Industrial Recovery Act, with proper changes, for at least two years after June 16, was strongly urged before the Senate finance committee on April 15 by Stephen F. Voorhees, chairman of the Construction Code Authority, who represented both the code authority and the Construction League of the United States. At the same time, the code authority filed with the committee a brief replying to the protest against the construction code previously filed with the committee by the National Association of Real Estate Boards on behalf of the Land Development and Home Builders' section (*ENR*, April 11, p. 535).

An important industry

As an introduction to the industry's specific recommendations, Mr. Voorhees pointed out the importance of the construction industry as the greatest employment agency in the country in normal times, its profound influence upon the economic conditions of the country as affecting the interests of millions of investors whose savings provide the capital required by the industry, its function in the fixation of national wealth, and finally, its position as the agency through which millions of unemployed are to be returned to useful pursuits under the present work-relief act.

The construction code, Mr. Voorhees declared, already has benefited the industry by bringing about closer cooperation and has benefited labor, first, through mutual or area agreements between employers and employees, which fix minimum wages, maximum hours and other conditions of employment, and, second, through the National Construction Planning and Adjustment Board with its broad program to improve employer-employee relations, including elimination of jurisdictional disputes.

No price fixing

The construction code was cited as unique in that there are no devices nor provisions embodied therein which tend to facilitate price-fixing, nor any tendency to monopoly or restraint of trade. The code, therefore, avoids the criticism levelled at certain other codes as to price-fixing, production control or monopolistic tendencies.

The following specific recommendations were made as to amendments and additions to be incorporated in the proposed bill:

1—Under Section 2c of the proposed act, that provision be made granting immunity from civil or criminal liability to code authorities and members thereof when acting within the scope of their authority.

2—That the words "truly representative" as used in the proposed act be clarified by defining them to mean those regularly engaged in the industry.

3—That Section 12 of the proposed act be amended to permit a code authority to proceed against a code violator by filing complaint directly with the U. S. district attorney and making the district attorney responsible for prompt prosecution if, in his judgment, prosecution is justified by the facts.

4—That there be added to Section 7 of the proposed act a new paragraph which will provide for collective bargaining by representatives of employers and employees selected by a majority of those voting at an election when all employers and employees affected have been given an opportunity to vote.

Mr. Voorhees was interrogated by the committee as to whether, with respect to recommendation No. 4, he favored majorities controlling minorities in all actions. He replied that the construction code provides for the effectuation of mutual or area agreements fixing minimum labor conditions by truly represenative groups of employers and employees concerned, but that in cases where the trade associations or labor unions did not provide, or could not muster sufficient strength to be deemed truly representative consideration should be given to other plans for effectuating these agreements. He indicated, also, that under the conditions of large turn-over in employer units, within the construction industry, truly representative character should be determined from those regularly engaged in the industry, which is the basis for recommendation No. 2.

Replying to a query from the commit-

(Continued on p. 575)

New Plans for San Gabriel Dam Approved by County Supervisors

Modified plans and specifications for the construction of San Gabriel Dam No. 1 for the Los Angeles, Calif., County Flood Control District were approved April 10 by the Los Angeles County Board of Supervisors. The revised plans, presented to the board by C. H. Howell, chief engineer of the flood control district, will be submitted immediately to State Engineer Edward Hyatt for his approval, required before work on the project can be resumed. Construction was suspended on Nov. 14, 1934, pending redesign. It is anticipated that the state engineer's report will be made before the expiration of the thirty-day period allowable for consideration of such matters and that the construction will be resumed immediately, putting approximately 400 men back to work.

Under the new specifications, the dam will be built of material from Quarry No. 10 in San Gabriel Canyon (½ mile downstream from the dam). The dam slopes will be widened to permit the use of material from Quarry No. 10, a large share of which under the original specifications was considered waste. The base of the dam will be widened from 900 ft. to about 1,800 ft. Approximately 9,000,000 cu.yd. of material will be used, instead of 5,000,000 cu.yd. as originally planned.

The estimated cost of the redesigned structure is $11,743,310, including a spillway to cost approximately $1,500,000. The contract price under the old specifications was $8,600,527, which did not include the cost of a spillway.

Construction League Reports on Handling of Relief Work

METHODS for handling construction operations under the Emergency Relief Appropriation Act of 1935 have been proposed to the federal government by the Construction League of the United States. The League's recommendations were prepared by a special committee on work relief program, consisting of S. F. Voorhees, chairman, E. J. Harding, George T. Seabury, F. P. Byington, Gordon Marshall, John H. Zink and B. R. Value. The work of this committee was supplemented by that of four other committees, the architects and engineers committee, contractors, manufacturers, and classification and qualifications committee.

The construction code authority at its annual meeting held on April 11 endorsed the principles and recommendations set forth by the Construction League and authorized its executive committee to cooperate with the League in developing the program.

The following is a summary of the recommendations of the committee on work relief program.

Classification

In order to eliminate waste and inefficiency it is essential that the unemployed drawn from relief rolls should be put to work on projects suited to their capabilities, and at rates of pay established by the act.

An accurate occupational classification on the basis of experience, training and skill in the several occupations should be made, and persons claiming to be qualified for employment on construction should be subjected to examination as to competency.

Duplication of enrollments and of employment services should be avoided.

To every construction project there should be an assignment of apprentices based on a practical working ratio to the number of skilled mechanics employed in order to give vocational training to the youth of the country who have never had a job.

Design of projects

The professional services of engineering and architectural firms should be engaged on a percentage fee basis where practical; otherwise on a fee basis which should provide for payment of a per diem or weekly fee for principals and for supervisory assistants, and an allowance for overhead expenses, together with the actual salaries for relief workers.

The competency of workers should be determined by the professional firm with authority to dismiss incompetent workers and to employ competent men from local unemployed if competent men are not available on their relief rolls.

Regular employees in public agencies and private enterprise should not be replaced by persons drawn from relief rolls, nor should the work customarily performed by such agencies and enterprises be transferred to new agencies created to provide employment for relief workers.

Selection of architects and engineers for these professional engagements should be done locally through properly constituted architectural and engineering boards whose members should be required to agree to non-participation in the actual work under the program, and who would be compensated on a basis of either actual expenses or time expended or both. The members of these national and local selection boards should be appointed by the President from nominations made by the construction code authority.

Construction contracts

All work possible should be executed under lump sum or unit-price contract awarded through competitive bidding. Where management contracts are deemed more feasible a fixed fee rather than a cost percentage should be used.

The contract should provide that the contractor may employ a small administrative and supervisory force of his own choosing and that other employees shall be drawn from relief rolls when properly qualified men are available. The contract should stipulate wages to be paid each class of employee.

The relative competency of workers should be left to determination on the job, and, subject to this necessary restriction, the contractor should have a right to dismiss or transfer workers or recommend their reclassification. Where no competent men are available on relief rolls, workers should be obtained as far as possible from local unemployed.

Selection of contractors and subcontractors on the management type of contract should be done locally through properly constituted industry boards similar to those for engineering and architectural work.

Construction materials

Construction materials for relief work should be purchased through the usual distribution channels by the contractors. However, where direct bulk purchase by government procurement offices is found to be necessary, the government should restrict its centralized purchases to a few standard items in carload lots. The government should deal with an industry as a unit through its recognized trade association or code authority and not attempt to break down either the distribution system or the firm's competitive price structure.

A national advisory body representative of the construction industry should be established by the President to aid and advise the Administration on policies and procedures to the extent that the relief program utilizes construction to accomplish its purpose.

Gasoline Tax Increase Fails

The Pennsylvania Senate, by a vote of 26 to 17, killed a bill that would have increased the state's gasoline tax of 3 cents to 5 cents per gallon. The bill had passed the House by a vote of 133 to 87. It was expected to have added about $40,000,000 to the state's income from the gasoline tax.

Moffett Resigns as Head of Federal Housing Administration

The resignation of James H. Moffett as Federal Housing Administrator was accepted on April 15 by President Roosevelt. Mr. Moffett, who has headed FHA since its beginning, desires to take a vacation and then return to private business. To date, the FHA renovation program has generated about $350,000,000 worth of business and given work to some 750,000 persons, according to Mr. Moffett. Definite pledges, he said, have been obtained for an additional $347,000,000 to be spent this spring and summer. The mortgage insurance activities of the FHA, by which it is hoped to generate new private construction, are just now getting under way.

Building Material Developments To Be Chemical Society Topic

The use of chemical research as an aid to building recovery will be the chief topic at the national symposium of the American Chemical Society in New York, April 22 and 23. The building industry is entering a period of revival and expansion and its progress will be speeded by the advance in chemical science, according to a statement by Prof. J. R. Withrow of Ohio State University. The lull in activity occasioned by the depression has given the necessary time for improvement in materials through added use of chemical research. As a result of this research, Prof. Withrow adds, basic building materials will be much better.

Sessions of the symposium will take up the following general topics: problems of the construction industry; correlation of chemical developments to building uses; influences of codes on new materials; cement and concrete problems; air conditioning and insulation; smoke and fire protection.

Fort Peck Engineers Report Completion of Two Pilot Tunnels

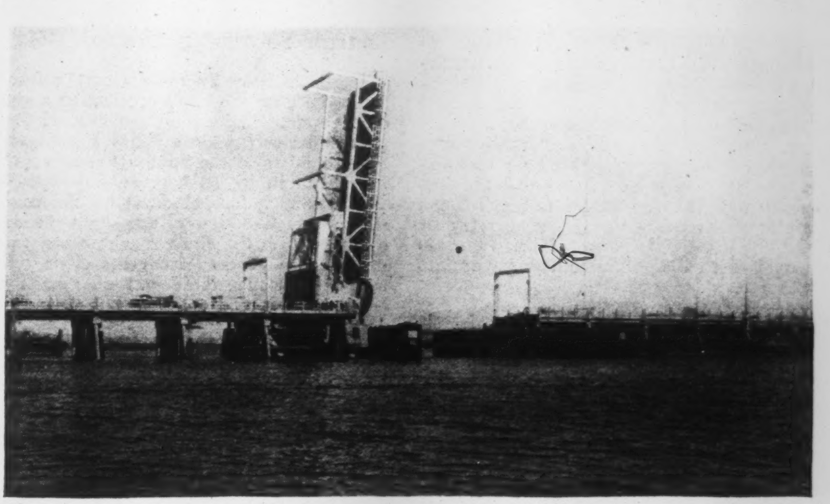
Two pilot tunnels of the dam at Fort Peck, Montana, were holed through on April 11, according to an announcement from the district office of the Army Engineers. Only one more tunnel remains to be completed. The longest tunnel, No. 4, with 308 ft. yet to be dug, will not be holed through for another week. A total of 24,012 ft. of pilot tunneling had been completed up to April 8.

High Land Prices Cause PWA To Abandon Chicago Housing

The Public Works Administration has abandoned its $12,500,000 slum clearance project on Chicago's West Side because of organized attempts to sell the land to the government at excessive prices. Only if a smaller area within the 165-acre site can be obtained at fair market prices will PWA go ahead, but Administrator Ickes emphasized that it will only be a very small section, if any.

Lawyers were blamed by Administrator Ickes for building up hopes that can never be realized by soliciting property owners to sign contracts authorizing them to bargain for prices in excess of government offers on a contingent fee basis. Mr. Ickes also scored mortgage companies for attempts to use the government as a collection agency, and referred to speculation in mortgages as a factor which has blocked the housing project. He explained that other difficulties were encountered in obtaining land because home owners naturally regard their property as worth more than its present fair market value. This figure is often less than its original purchase price and sometimes less than the amount for which it is mortgaged.

PWA had not purchased any land but had a considerable amount under option.



CAUSEWAY CONNECTS MARE ISLAND TO MAINLAND

A new causeway connecting Mare Island with the mainland at Vallejo, Calif., was opened to traffic about the middle of March. Mare Island, site of the U. S. Navy Yard, is in San Pablo Bay to the north of San Francisco Bay. The causeway is 4,500 ft. long, consisting of 2,500 ft. of earth embankment and 2,000 ft. of 36-ft. concrete girders carried on bents formed of concrete piles. A bascule bridge of 101-ft. span is included. The causeway was built by the Bureau of Yards and Docks, U. S. Navy, under the direction of Rear Admiral Norman M. Smith, C.E.C.

Extensive Housing Program Advanced in Canada

Recommendations for a Dominion-wide housing program have been submitted to the Parliamentary committee of housing by the National Construction Council of Canada. They call for the inauguration of a $120,000,000 government-financed slum-clearance and replacement campaign, and government-guaranteed loans aggregating $20,000,000 for rehabilitation of improved property, and $100,000,000 for residential construction other than for the lowest income group. The plan would be carried out over a period of five years.

The National Construction Council of Canada is representative of professional organizations concerned with the building business. For the administration of its plan, it advocates the creation of a national housing bureau, to function under the Ministry of Health. Funds for slum clearance and replacement schemes would be advanced on approval of the bureau through local public utilities or private limited dividend corporations. Rates of interest on this money would not exceed 1½ per cent, as it is the purpose of the council that it would be employed in construction of housing for wage earners unable to pay more than $15 per month in rent.

For construction of residences for more highly paid groups, the council proposes that loans be made through the existing financial institutions. This would be available to approved borrowers up to 80 per cent of the cost of project, and at a rate of 5 per cent, with a long period of amortization.

It is expected that the Parliamentary committee will report shortly after Easter, and that the committee's recommendations to the government will be substantially those of the National Construction Council.

Crossing Elimination Proposed For Region South of Chicago

Elimination of 44 grade crossings in Hammond and Lake County, Ind., which will cost $7,000,000 for track elevation, to eliminate the Lake County traffic bottleneck into Chicago, has been proposed by Mayor Martin, of Hammond, for federal financing. The project is to be proposed for financing from the $800,000,000 earmarked in the work relief bill for highway purposes. The mayor stated that the proposal has the approval of the Indiana highway commission and the director of the FERA in Indiana. Nine railroads would use the elevated trackage into Chicago.

Vermont Plans Two Bridges Across Lake Champlain

Matching similar action by New York, the Vermont legislature has approved bills creating two commissions with authority to proceed with plans for the construction of two bridges over Lake Champlain. One commission will have power to act in cooperation with a similar New York commission to plan for a bridge linking Alburg, Vt., with Rouses Point, N. Y. The other bridge will connect East Alburg and West Swanton, Vt., and will be a link in the bridging of Lake Champlain.

Caddoa Conservancy District Created by Colorado Legislature

A bill establishing the Caddoa dam conservancy district and providing for an organization to seek PWA funds for the construction of a dam across the Arkansas River near Lamar has been passed by the Colorado legislature and signed by Governor Johnson. An enabling act for a compact between Colorado and Nebraska regarding division of the waters of the Republican and Arickaree rivers also has been passed and signed by the governor.

Code Authority Acts On Withdrawal of Sub-Bids

The Divisional Code Authority for General Contractors has announced that it will give its full support to protect contractors from the withdrawal of sub-bids on orders of other code authorities. Numerous complaints have been received by the divisional authority that sub-bids that had been used by general contractors in making up their bids were subsequently withdrawn because code authorities governing subcontractors and material men alleged violations of their codes. Although the sub-bidders were willing to enter into contracts on the basis of their original bids, the action of their code authorities forced them to retract. The NRA recently ruled that such action was outside the jurisdiction of the code authorities, but these code authorities have been slow to recognize the ruling, and the divisional authority therefore has decided to act to protect general contractors from the forced withdrawal of sub-bids.

General contractors are asked to observe the code rule that unsolicited, or late, bids must be returned unopened to the subcontractors. Failure to observe this regulation has led to many complaints from subcontractors.

Court Refuses to Set Aside Detroit Sewer Verdict

The Michigan Supreme Court refused to set aside on the city's application a six-cent verdict obtained by the city of Detroit in its suit against Julius Porath and Sons, builders of the Southfield sewer (see *ENR*, March 16, 1933, p. 360).

The opinion handed down by the court stated that the sewer was built in accordance with the city's requirements, that the collapse resulted from the city's own neglect, and that there was no reversible error in the trial which resulted in the verdict.

After spending $355,411 for repairs to the sewer the city sued to recover, charging faulty workmanship and inferior materials. The sewer contract was let in Nov., 1936, at $690,762 and in Feb., 1930, a portion of the sewer collapsed. The Supreme Court found that there was ample evidence to sustain the contentions of the defendant company. It was maintained that the city was directly responsible for the collapse because it pumped quicksand from beneath the barrel of the sewer. It was further claimed that the city exercised its right of daily inspection and final acceptance and that in absence of fraud such acceptance stopped a suit for damages.

Disposition of Highway Funds In Arkansas Modified

A bill authorizing the governor of Arkansas to appoint the state highway director and requiring the highway commission to allot state construction funds to counties on a basis that includes population, area and automobile registration, has been permitted by Governor Futrell to become a law without his signature.

Some objection was raised to the bill on the ground that it might jeopardize allotments of federal funds to the state, but the bill contains a provision that the allotment schedule shall not prevent the Bureau of Public Roads or other federal agency from approving or making allocations of funds.

Condemnation for Housing Upheld by New York Court

The right of the New York City Housing Authority to condemn property for slum clearance has been upheld in a decision by Supreme Court Justice Charles B. McLaughlin. The decision is regarded as of great importance to the federal housing program as it is the first decision on whether slum clearance and low-cost housing constituted a public use justifying condemnation.

In granting the Housing Authority the right to condemn property on East Third Street, Justice McLaughlin held that even though the new housing could be used only by a limited number of persons the abolition of disease-breeding slums for the benefit of all the people is a public use.

A federal judge in Ohio upheld the constitutionality of condemnation, and a federal judge in Kentucky claimed the government had no such power. Should the United States Supreme Court uphold the Kentucky decision, Justice McLaughlin's ruling would give precedence for similar state rulings enabling the Federal Housing Administration to work through state agencies in condemnation proceedings.

Waterworks and Sewers Approved for Montreal

Waterworks and sewer projects totaling $2,322,000 have been approved for the city of Montreal by the provincial legislature and are expected to get under way in the near future. The major waterworks item is the reconstruction of the existing intake system from the St. Lawrence River at Ville Lasalle. This project is estimated to cost $1,200,000, while a partial reconstruction of the Cote des Neiges reservoir is to cost $300,000. New pumps at one of the main pumping stations are estimated at $65,000. Miscellaneous items will make up the rest of the $1,665,000 approved for the waterworks program.

Most of the $657,000 for sewer construction is required for a trunk sewer on Trenholme Ave., at the west end of the city, which will serve as an extension of the recently completed high-level St. Pierre collector sewer. The estimated cost of this work is $400,000.

A project for a second vehicle tunnel under the Lachine Canal, to relieve traffic congestion, was not approved by the legislature.

Work on Taylor Park Dam To Get Under Way Soon

Between 200 and 300 men are expected to start work on the $2,400,000 Taylor Park Dam in western Colorado in a very short time, officials of the U. S. Reclamation Service announced. Work will start as soon as the contract is signed. The dam will supplement the irrigation supply of the Uncompahgre project, now dependent on the natural flow of the Gunnison River diverted through the Gunnison tunnel.

New Land Boundary System Established in New Jersey

An act establishing a system of land boundary description by tying them to a system of accurately established monuments throughout the state has been passed by the New Jersey state legislature. The triangulation or traverse stations are to be established in conformity with the standards adopted by the U. S. Coast and Geodetic Survey for first- and second-order work.

The act provides that no survey of land hereinafter made shall have endorsed thereon any legend or other statement indicating that it is based on the New Jersey system of plane coordinates unless the coordinants have been established on the basis outlined above. Much work already has been done on the establishment of a plane coordinates system, and on a local control survey, both under the direction of the U. S. Coast and Geodetic Survey.

Poor Supervision Aided Failure of Roof in Vancouver

Reporting to the Vancouver city council on the collapse on Jan. 21 of the tied-arch timber roof of the Forum Building under a heavy load of snow, the special investigating committee appointed by the council criticizes the city's handling of the design, supervision and inspection of the structure. The committee, composed of Prof. A. H. Finlay, assistant professor of civil engineering, University of British Columbia; A. L. Mercer, architect, and W. O. Markle, prominent builder, agrees with previous findings that the design of the roof was inadequate for the load imposed, which it estimates to have been 15 lb. per sq.ft. on the west side of the roof and 7½ lb. per sq.ft. on the east. The committee also calls attention to the fact that the roof sills rested on brackets at each pilaster, creating an eccentricity of load of 1 ft. 3 in. The report is particularly critical of the manner in which city officials handled the design, and states that the most serious reflection on the affair is that such a roof should have been specified, approved, and used on a public building without first obtaining advice as to its suitability. In its investigation the committee found that there had been such divided responsibility that no one would acknowledge free use of his own judgment in matters pertaining to this roof. Surprise was voiced by the investigators that there was so little information about the roof in the city architect's files, and that the designer could not obtain a copy of the city building bylaw or data on loadings. The roof was designed by the Lamella Roof Syndicate.

Irrigation Storage Remains Below Last Year

Water supplies in the irrigation storage reservoirs in the West have remained low during the winter, after a dry season in 1934 following an accumulated deficiency of supply for several years. In March, however, a gain on the deficiency over last year was recorded. As of April 1 the total amount of water stored in the reservoirs of the U. S. Bureau of Reclamation was about 4,700,000 acre-ft. as against 5,400,000 acre-ft. on April 1, 1934. The gain of storage during March was about 1 million acre-ft. As the deficiency over last year on March 1 amounted to 1,600,000 acre-ft. (3,700,000 against 5,300,000), the deficiency was materially reduced by March runoff.

On the Belle Fourche project in South Dakota the storage supply available for irrigation is about one-half of the requirements of a normal season and only 40 per cent of the quantity needed for a very dry summer. The flow of the Wind River, at Riverton, Wyo., was 25 per cent less than normal for March but at Shoshone, Wyo., an ample supply of irrigation water is assured. On the North Platte project, Nebraska-Wyoming, the storage supply is at a record low and the outlook is very poor. Sun River, Mont., reports dry ground and short storage supplies. At Minidoka, Idaho, there was a marked improvement in water supply during the month but on the Boise project the available runoff was estimated April 1 at 31 per cent below normal.

Conditions are favorable on the Hyrum project in Utah. At Ogden River, the shortage is not as great as last season but stream flow on the Provo River and Moon Lake projects in the same state are the lowest on record. At Uncompahgre, Col., mid-season irrigation will depend largely on a sudden or delayed spring runoff. Carlsbad, N. M., reports that severe drought conditions persist over the entire Pecos watershed and Yuma, Ariz., that the Colorado River flow will probably exceed that of 1934 but will be considerably below normal.

East of the continental divide drought conditions continue with little change except along the extreme eastern edge of the Great Plains. Especially severe and prolonged dust storms from continuing dry weather occurred during the past week in western Kansas and Oklahoma.

Over Half of the Relief Funds to Go Into Normal Business Channels

NEARLY 60 per cent of the four billion work relief funds will go into the purchase of materials and equipment, according to estimates based on past expenditures of Recovery Act money by the federal government. The actual distribution will depend upon how much money is spent on types of work in which the direct labor cost is high, but based upon the allocations of the relief funds made by Congress the total for materials and equipment should be $2,355,000,000, as shown in the accompanying table. The President is authorized to transfer up to 20 per cent of these allocations, hence figures are tentative at best.

Out of every dollar spent by the PWA, 34 cents has gone to labor on the site and 56 cents for equipment and material. On the present relief projects on the other hand 90 cents of every dollar has gone to labor.

On highway construction for which $1,500,000,000 is expected to be spent this year and next, the average is expected to be 30 per cent for payrolls, or $450,000,000, with $1,050,000,000 for materials, machinery, supplies, overhead and profits. The total for roads is made up of $800,000,000 in the Relief Act, $480,000,000 of state funds, $250,000,000 for regular federal-aid construction, and $52,000,000 remaining of the $200,000,000 appropriated by Congress last year.

Of the total of $651,000,000 distributed by the CCC since it was organized in April, 1933, through February of this year, $293,000,000 went into payrolls, $24,000,000 for land purchases and the remainder, $334,000,000 had gone for supplies and equipment.

Hoping for the best on public works, Mr. Ickes is ready to set up miniature PWA organizations in each state to speed up handling of project applications. A shift from the 30 per cent grant, 70 per cent loan to a 50-50 basis on non-federal projects is reported to be under consideration. Likewise, it is expected that if the government can borrow money at less than 3 per cent, it will be loaned to states, counties, towns at less than 4 per cent.

DISTRIBUTION OF RELIEF FUND BETWEEN MATERIAL AND LABOR

	Allocation	Direct labor	Materials, supplies, machinery, transportation
Highways and grade crossing elimination	$800,000,000	$240,000,000	$560,000,000
Rural rehabilitation	300,000,000	180,000,000	120,000,000
Reclamation and irrigation	200,000,000	60,000,000	140,000,000
Rural electrification	100,000,000	40,000,000	60,000,000
Housing	450,000,000	150,000,000	300,000,000
White collar projects	300,000,000	225,000,000	75,000,000
Civilian Conservation Corps	600,000,000	300,000,000	300,000,000
Forestation, prevention of soil erosion, flood control, rivers and harbors	350,000,000	150,000,000	200,000,000
State, county and municipal waterworks, sewerage, power plants, etc.	900,000,000	300,000,000	600,000,000
Totals	$4,000,000,000	$1,645,000,000	$2,355,000,000
Per cent of total	100	41.1	58.9

Dust Storms and Drought Control Raise Serious Political Situation

(Washington Correspondence)

MOST of the drought area of 1934 has been partially or wholly relieved, by fall and winter precipitation, but there still remained on April 1 a considerable area of the Great Plains where conditions were worse than at the same time last year. The lack of early spring rains has also resulted in the unusually wide spread dust storms of March and April. Although these storms have seriously affected certain areas, the crop loss from a national standpoint is relatively unimportant. Popular hysteria, however, caused by the increasing frequency of the dust storms has reached a pitch that Washington realizes may have dire political as well as economic consequences. Control of soil erosion has forced its way to the front as a major issue that is loaded with dynamite because preventive measures applied now will have no discernible effect for several years to come.

The President assured a delegation of Western senators and representatives on April 10 that everything in reason would be done to halt soil erosion. The delegation asked the President to apply $50 millions this year and $100 millions next year for control measures out of the four billion dollar work-relief fund.

The law carries a blanket allocation of $350 millions for prevention of soil erosion, seacoast erosion and stream pollution, for forestation, reforestation, flood control, rivers and harbors, sanitation and miscellaneous projects. Within this broad classification, the President can shift funds at will, and, if expedient, raise the total by curtailing other allocations made by Congress.

The Senate Committee on Agriculture reported on April 11 the bill passed by the House on April 1 declaring it to be the policy of Congress to provide for control and prevention of soil erosion. The bill gives permanent status to the Soil Erosion Service, created by Secretary of the Interior Ickes in September, 1933, and recently transferred to the Department of Agriculture.

The department is authorized by the bill to conduct surveys and cary on preventive measures by cooperating with or furnishing financial or other assistance to agencies, public or private, and individuals. The department is empowered to acquire lands or rights in land by purchase or condemnation, and as a condition to benefiting lands not owned or controlled by the government, to require enactment and enforcement of local laws imposing restrictions on use, to negotiate agreements having the same effect, and to require contribution in money, services or materials.

Bond Sales Permit Minneapolis To Reduce Loan from PWA

For the third time the Public Works Administration has reduced the total of its combined loan and grant to the city of Minneapolis, Minn., for sewer construction and a sewage treatment plant. This has come about through the ability of the city to market its bonds in the private investment market. The present reduction is $1,000,000, reducing the loan and grant to $8,140,000. The original allotment was $11,526,000. The reduction in the allotment affects the loan portion only and has no effect on the grant which remains 30 per cent of the cost of labor and materials.

Maine Passes Registration Law For Professional Engineers

A bill calling for the registration of professional engineers practicing within the state of Maine, passed recently by the state legislature, was approved by the governor on April 6. It becomes effective 90 days after being signed by the governor.

As originally drafted, the bill included land surveyors, but land surveyors were omitted in the bill as finally approved by the legislature. Considerable opposition arose to including land surveying under the act for fear that it would have an adverse effect upon the so-called practical land surveyors and timber cruisers, of whom there are many in the state.

In its original draft, the new law followed the model registration law for engineers very closely except as to fees and renewals, but its phraseology was altered considerably in the legal affairs committee of the legislature, to which it was referred. This committee also reduced the required amount of practical experience from four to three years. This was a compromise. Lawyers are admitted to practice immediately upon graduation and the lawyers on the committee thought the four-year period too long.

Within five years after the act becomes effective, the board of registration is empowered to accept as evidence of qualification for registration, a specific record of 12 years or more of lawful active practice of engineering work of a character satisfactory to the board, including at least five years of responsible charge of important engineering work. The registration fee is $15 and renewal fees may not exceed $3 nor be less than $1. A registration fee of $10 is provided for practitioners who apply for registration within one year after the act becomes effective. The act provides for reciprocity with states whose requirements are not lower than those set in the act.

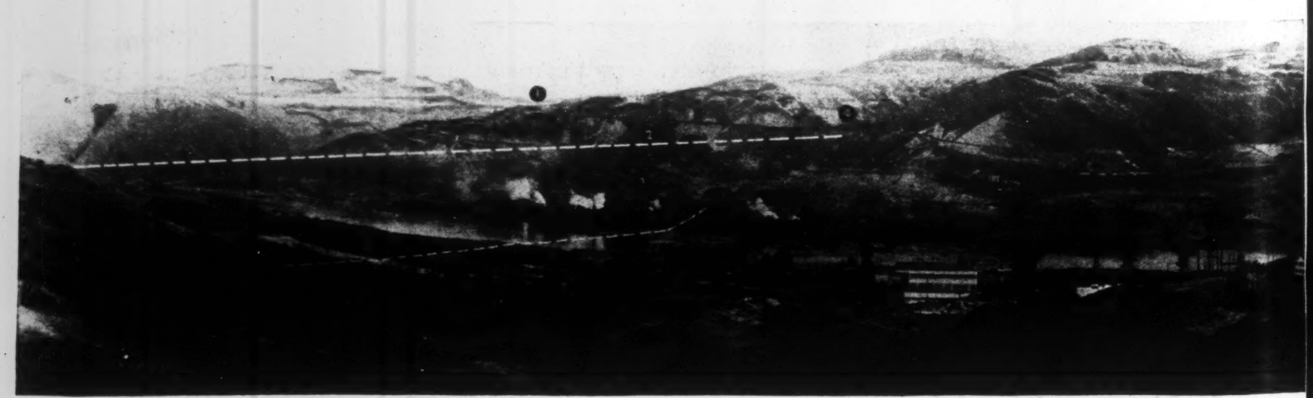
CONSTRUCTION OPERATIONS COVER WIDE AREA AT GRAND COULEE DAM

Both banks of the Columbia River at the site of Grand Coulee Dam now are filled with activity, as shown by the accompanying panoramic photograph which is taken from the east bank. The river flows almost due north at the site.

The approximate position of the high dam is shown by dotted lines. At point (1) is the upper end of the Grand Coulee, the site of the reservoir for storage of irrigation water; (2) indicates the grade line for the government railroad; (3) is the mile-long conveyor system for removal of overburden from the dam site; (4) is where the axis of the dam intersects the west abutment; the railroad tunnel is at (5); the permanent highway bridge will be at (6); the temporary bridge being somewhat farther upstream, and the railroad bridge is at (7). Along the bank of the river below the point (3) the driving of the west cofferdam is in progress. The permanent town, now the site of the camp of the engineers of the Bureau of Reclamation, is on the west bank below point (5), and the contractors' camp, housing nearly 4,000 employees, is shown in the center of the right-hand section of the picture. It is called Mason City after Silas Mason of the contracting firm of Mason-Walsh-Atkinson-Kier Company.

Since this picture was taken the railroad bridge has been completed and has been decked for use as a temporary highway bridge, thus making it possible to dismantle the temporary trestle before high water.

The west side cofferdam also has been completed since this picture was taken.



Construction Code Extension Asked By Code Authority

(Continued from p. 570)

tee as to whether building prices had not increased under the code, Mr. Voorhees testified that from his own experience as a practising architect, bids submitted recently on comparable projects are much lower than from 3 to 5 years ago, but that he could not speak for the construction material industry which, with two minor exceptions, are under other codes.

Real estate boards answered

The code authority in its brief filed with the finance committee struck out vigorously at the proposal of the National Association of Real Estate Boards that house building operations be excluded from jurisdiction of the construction code. The code authority asserted that speculative home building has been one of the greatest disturbing factors in the construction industry, not only from a labor standpoint, but from a value standpoint, and because of which the various Federal Home Loan Corporations have had to be created in order that many Americans might not lose their life savings and the Federal Housing Administration has been established to eliminate the evils of the short term mortgage practices. The brief reiterates that there is no logical reason for separating therefrom construction operations by the realtor who is generally only a distributor and not a producer.

Regarding the claim that the code authority of the construction code is not representative, the brief states that when a group qualifies with sufficient representation to become a chapter of the code, it automatically received representation on the code authority; also that more than one-half of the homes built in the country are constructed by contractors who are members of the construction industry as codified.

The code authority disclaims that the construction code is responsible for any decrease in construction employment, particularly with reference to dwelling construction. It emphasizes the fact that the construction code does not embrace construction materials and that any increase in labor costs would be small compared with the high costs prevalent under the practices prevailing in speculative house building.

SOCIETY CALENDAR

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D. C., May 2 and 3.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

AMERICAN INSTITUTE OF ARCHITECTS, annual convention, Milwaukee, Wis., May 28-30. **THE PRODUCERS' COUNCIL** will hold its 12th annual meeting in connection with the Institute meeting.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

PENNSYLVANIA SOCIETY OF PROFESSIONAL ENGINEERS, Philadelphia, Pa., May 2.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, New York, May 18, 1935.

Personals

John C. Fink, former head of the engineering force of Walter Kidde Constructors, Inc., New York, has entered the Department of Interior as progress engineers in the division of subsistence homesteads. Mr. Fink is stationed at the Washington office.

James Arthur Reed, third district engineer in the division of subsistence homesion, has been appointed by Governor Laffoon to fill the vacancy occasioned by the resignation of Thomas S. Rhea. Mr. Reed has been with the highway department for fourteen years, starting as a rodman on his graduation from the University of Kentucky. Later he became resident engineer and since 1932 he has been stationed as engineer at Russelville.

R. J. Lecky, secretary of the Building and Construction Industries Exchange and the Vancouver General Contractors Association, has resigned that position and has established a new organization known as the Quantity Survey Bureau at Vancouver, B. C. Mr. Lecky has been in the contracting business in Canada for many years. He was at one time superintendent for Peter Lyall & Sons, and erected the Parliament buildings in Regina for that firm.

D. Grant Mickle, formerly associated with Miller McClintock, has joined the staff of Jensen, Bowen and Farrell, public appraisal engineers, which has set up a traffic and transportation department covering highway traffic consulting work and geneal highway transport engineering. Mr. Mickle conducted traffic research at the Erskine bureau for street traffic research at Harvard University, was employed for several years in the traffic division of the Massachusetts Department of Public Works, and directed the public works studies on the Massachusetts highway accident survey following which he entered the employ of the U. S. Bureau of Public Roads.

Brief News

Construction of the Grand Island bridges between Buffalo and Niagara Falls, N. Y. is expected to be completed in time to have the bridges opened to traffic on July 1.

Creation of a Planning Commission for the city of Montreal has been ratified by the legislature of the Province of Quebec. The committee will be composed of six members with H. E. Terrault, former city engineer, as chairman.

Bids on the Alton Dam, Alton, Ill., were received at the U. S. Engineers Office, St. Louis, on April 11. The lowest bid, $4,865,717, was submitted by the Engineering Construction Corp. of New York. The cost of the dam had been estimated at $4,210,792.88 by Army engineers.

Approval of Uniform Size and Weight standards for motor vehicles proposed by the American Association of State Highway officials will be considered by the United States Chamber of Commerce at its annual meeting at Washington on April 29. A special committee of the highway officials approved the uniform limitation in December. At a meeting of the transportation committee of the Philadelphia Chamber of Commerce this month approval of the uniform standards was defeated.

A Study of High Velocity Conduits involving flood control conditions has been proposed to the board of supervisors of Los Angeles County, Calif., by C. H. Howell, chief engineer of the county flood control district. Mr. Howell has asked for an appropriation of $5,000 to employ the facilities of the California Institute of Technology at Pasadena, to make such a study in connection with the proposed flood control improvements in La Crescenta-Montrose area of the county.

Obituary

FREDERICK MITCHELL, of Brooklyn, N. Y. died April 8th at Polyclinic Hospital from injuries received in a blast on the Midtown Hudson Tunnel. Born in England, he came to this country when the Hudson and Manhattan tunnels were being built and held many responsible positions on tunnel jobs in various parts of the United States and Mexico. He was a superintendent for Mason & Hanger Co., Inc. on the Midtown Hudson Tunnels.

THOMAS W. LESAGE, former consulting engineer for the waterworks department of Montreal, died at his home there on April 9. Mr. Lesage was born in Montreal 64 years ago. He was first employed in the water department from 1887 to 1890. From 1890 to 1900 he was with the department of roads and in 1901 he was appointed assistant superintendent of waterworks. In 1911 Mr. Lesage became superintendent, and held this position until his resignation in 1921. After his resignation he was retained as consulting engineer until his retirement on January 1, 1935.

O. E. STEWARD, a director of the Metropolitan Water District of Southern California, representing Anaheim, Calif., was killed April 7, in an automobile accident while on an inspection tour of the aqueduct with several Anaheim city officials. Mr. Steward, 50 years of age, had been a director of the Metropolitan Water District since its inception in 1929. As a civil engineer he had taken an active interest in engineering problems in Southern California for many years. He was a former city manager of Anaheim and was the engineer in charge of constructing the Orange County joint outfall sewer, completed ten years ago, and had since been maintenance engineer.

KENNETH BAKER WARD died March 27 at Painesville, Ohio. He was born at Willoughby, Ohio, in 1883 and graduated from Ohio State University in 1905. For seven years thereafter he was professor of civil engineering at his alma mater. In 1911 Mr. Ward was admitted to the bar. In 1916 he became first city manager of Sandusky, Ohio, and went to Chicago where he held several positions as structural engineer. In 1917 he became city manager of Durham, N. C. Recently he was connected with Griffenhagen & Associates in Chicago, and was construction engineer for Clark Management Corporation. Mr. Ward was past president of the Chicago chapter of American Association of Engineers.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards for the week total $26,087,000 of which $10,029,000 is private work and $16,058,000 is public construction. Of the public awards, $2,711,000 is federal and $13,347,000, state and municipal. All three classes of work are lower than the record high volume in each last week.

Highway awards at $2,145,000 are the lowest for any week this year or last. Bridges at $428,000, also are low, while waterworks are higher at $4,205,000, and sewerage awards are higher at $1,362,000. In the building awards, commercial buildings total $3,528,000 for the week, industrial buildings, $3,544,000 and public buildings, $5,508,000, all under the exceptionally high volume of last week but well ahead of the average week to date.

The larger contracts include a gasoline cracking plant for Wilshire Oil Co., Norwalk, Calif., $1,000,000; electrical equipment for steel strip mill for Bethlehem Steel Co., $1,250,000; junior-senior high school, Allegheny County, Cumberland, Md., $537,000; completing arena section of municipal auditorium and community center, St. Louis, Mo., $1,165,000 and parcel post building, Detroit, Mich., $775,000. In San Francisco, contract was let for raising dam at Hetch Hetchy Reservoir, $3,220,000; at Richmond, Ind., activated sludge type sewage disposal plant and interceptors were let at $470,000; and at East Boston, Mass., the Eastern Racing Assn. awarded contract for race track, grandstand and related facilities at $2,500,000.

State and municipal bond sales were lower due to the absence of any large issues. They totalled for the week only $2,614,000. Reductions and rescissions of PWA allotments again exceeded reallotments with the net result of lowering the amount of PWA allotments outstanding by $725,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Apr. 1934	Average Prev.4 Weeks	Week Apr.18 1935
Federal Government	$6,389	$4,236	$2,711
State and municipal	15,432	14,799	13,347
Total public	$21,821	$19,035	$16,058
Total private	4,781	8,627	10,029
Week's total	$26,602	$27,662	$26,087

Cumulative to date:
1934...$462,253,000 1935...$403,606,000

NEW PRODUCTIVE CAPITAL

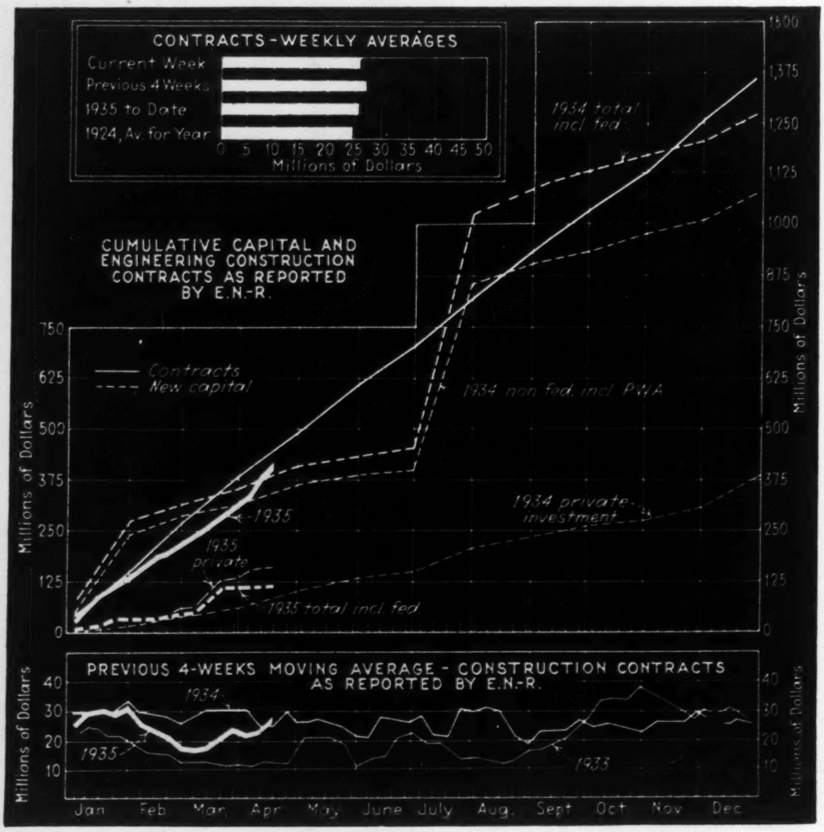
(Thousands of Dollars)

1935	Week Apr.18	Cumulative
State and municipal.....	$2,614	$134,243
PWA allotments, S&M..	—1,725	—46,675
RFC loans, S&M.......	....	84
Corporate issues	....	....
PWA allotments, private	1,000	8,129
Total, Non-Federal ...	$1,889	$95,781
PWA allotments, Federal Constr.	.....	7,336
Total new capital....	$1,889	$103,117

Cumulative to date:
1934...$398,134,000 1935...$103,117,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.

INDEX NUMBER

E.N.R.- Cost	1913 = 100	1926 = 100	E.N.R.- Volume	1913 = 100	1926 = 100
Apr., 1935..	**194.50**	**93.49**	**Mar., 1935.**	**101**	**44**
Mar., 1935..	194.26	93.38	Feb., 1935.	76	33
Apr., 1934..	195.86	93.90	Mar., 1934.	116	51
1934 (Av.)...	198.10	95.23	1934 (Av.)..	114	50
1933 (Av.)...	170.18	81.80	1933 (Av.)..	102	47
1932 (Av.)...	156.97	75.45	1932 (Av.)..	127	56